Personal Understanding and Target Understanding:
Their relationships through individual variations and curricular influences

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Abstract

The current trends in educational research, in educational theory (academic and applied), and in educational practice have brought to the fore, issues of what understanding in educational contexts entails.

These pressures to develop a concept of educational understanding are examined and, following Bereiter, a distinction is made between explanatory theories which seek to interpret how understanding develops in educational contexts along with why there are variations in understanding, and instructional theories which seek to specify what understanding should be as developed by a person in an educational context.

It is argued that, at the level of educational theory, understanding in educational contexts can only be fully explained in terms of the life milieu of the person -that is, the person's developmental history as an individual in a range of physical and social contexts - and in terms of the relationship between education and the society within which it is practised. An adaptational framework is suggested with the key idea of understanding as being various forms of relationships between the *personal understanding* of the individual and the *target understandings* of the contexts that individual encounters in life. These relationships may range from complete lack of engagement between personal understanding and target understanding, through various forms of mismatch, to forms of relationship in which the adaptational specifications of the target are complied with. The target understandings themselves are viewed as being embedded like sets within a universal set of all possible understandings. Thus a particular target understanding in the curriculum, can be placed in a broader context of institution, social background, national purposes, norms and so on, as required by the explanatory goals of a particular research project.

The relevance of these concepts for both educational theory and practice are explored. Firstly, a study is made of ways in which personal understanding can be related to some issues in the psychology of the person. This leads to an outline for a concept of personal understanding which is particular to educational levels of explanation. Secondly, by means of concepts developed in the thesis, the nature of target understanding in educational contexts is explored, with the prime focus being upon the context of science education in schools. The target which the pupil is faced with is perceived as deriving in various complex ways from the nature of the subject discipline, the instructional theories of the syllabus designers, and the personal understanding and instructional theories of the teacher.

Implications are drawn for educational practice and curriculum development, for the further development of the framework, and for some current theories of understanding relevant to education. It is suggested that when the distinction is applied, explanatory theories and instructional theories of understanding can be developed in ways which are mutually beneficial. Instructional theories, and the practices which derive from them, provide data for explanatory theories, which can then be used to improve instructional theories in a continuing cycle. In time, this may provide a powerful tool for the development of education.

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Also, I would like to thank my wife and daughters for putting up with long periods of an absent husband and father. This thesis is dedicated to them.

This work is solely the work of the author, except where referenced.

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Chapter 1
Background to the thesis

If understanding is a primary goal of education, an effort to understand understanding would seem to be an obligation, even if one is convinced that it is likely to be only a partially successful effort. (Nickerson, 1985, p217)

Introduction

The above quote illustrates the aim of this thesis. It seeks to clarify the concept of *understanding* as used in educational contexts. It does so by introducing a distinction between 'personal understanding' and 'target understanding. The concept of *personal understanding* involves a description of understanding from the perspective of the individual. In an educational setting, it involves not only the grasp of the topic presented, but also an interpretation of the situation as a whole. It is, therefore, substantially influenced by that person's prior knowledge and experience, and also by attitudes and feelings relating to the learning context. Sometimes, that understanding will overlap substantially with meanings which others draw from the same context, but on other occasions there will be major differences. Where there is a noticeable difference, the tendency may be to call this a 'misunderstanding' or a 'failure in understanding'. However, it will be argued that what we are actually describing is a form of mismatch with a target understanding which has been set.

In formal educational contexts, the *target understanding* is decided by curriculum planners and formally defended in syllabuses. The target can be thought of as a set of adaptational specifications for the person. This specification derives from the way in which the set of ideas and information it comprises was drawn from a much wider array of knowledge. This derivation would depend upon such factors as the nature of the wider set from which it is extracted, along with decisions about what was appropriate for the purposes of the educator and what was an appropriate level for the student. However, the target is not just presented to the student as a written syllabus. There are also various processes in which the teacher interprets the syllabus and elaborates it through providing various forms of written material, through discussion and through explanation. The nature of the assessment procedures which are used tend to function to keep these processes within certain boundaries. They influence the teacher's presentation and, for some students, they influence the ways in which they study. The target actually perceived by the student, therefore, may come through a more direct pathway (the student reads the syllabus or extracts from it), and less direct pathways (the teacher acts as an intermediary in various ways). Thus, the target perceived by the student involves that individual in an interpretation of the teacher's

interpretation of what was intended by the curriculum planners. However, this interpretation by the student (personal understanding) also has a relationship with the broader life history of that person. This broader relationship is considered by further exploring a concept of adaptation.

An important distinction is also drawn between explanatory aims and instructional aims (Bereiter, 1990b)when discussing educational understanding. In both cases, we seek to examine the forms of match and mismatch between personal understanding and target understanding, but for different reasons. In instructional aims, understanding is judged against the aims of the educational context concerned. A mismatch between personal understanding and this target is generally taken as, either a failure to successfully teach for understanding, or as a failure of the student to attain an adequate or correct understanding. However, in explanatory terms, all outcomes in the relationship between the target understanding and personal understanding come within the description of understanding, since they also include the person's perspective. That is, in personal understanding, there is an interpretation of the context by the individual concerned. It is this interpretation which also needs to be explained, no matter how much we as observers (teachers, syllabus writers or researchers) judge it to be in error. On occasion, that explanation can only be found in the life history of the students and across the range of contexts they currently move in. That is, explanation of understanding may need to be found in the life milieux of the person, as well as in the immediate educational context.

In exploring the possibility of explaining understanding in this way, both personal understanding and target understanding prove to be complex concepts requiring careful elucidation. This thesis undertakes a conceptual clarification of these two terms by reviewing in detail a series of literatures which have discussed either understanding itself or related ideas. These literatures add additional perspectives on the overall analysis. By drawing key aspects out of these analyses, the nature of understanding gradually becomes clearer, until it is possible to present a conceptual framework intended to provoke further consideration of understanding within the context of teaching and learning in schools. In particular, the framework aims to make it possible for the development of both explanation and instruction in education to occur in a more efficient form of 'mutualism' than is currently the case.

Since the idea of understanding involves very abstract concepts, yet the aim is to have practical implications, it proves essential to ground the discussion from time to time in specific instances. Inevitably, the experience of the author provides the main focus for this. In consequence, illustrative instances are based largely upon the teaching of

science, particularly biology, within the Scottish education system. This means that target understanding has to be examined within a more general framework of the communication of ideas within science, and how science education relates to this.

Another feature emerges from the distinction between personal understanding and target understanding. It enables explanatory theory in education to be placed in a hierarchy of disciplines which contribute to, and constrain it, from above and below. It is, therefore, possible to approach the development of the conceptual framework for explaining understanding in a 'bottom-up' way from biology and psychology, or in a 'top-down' way from the social sciences. The thesis focuses mainly on the bottom-up approach, but some concepts are introduced or adopted in the progression to the final framework, which begin to show the kind of analysis from above which would further develop its scope. Figure 1 shows a preliminary representation of the above points and some of the concepts which will be introduced. However, as the final framework emerges some of these concepts will move to the background of the framework. They do not lose importance in explanation but, unfortunately, not all of the conceptual relations can be shown in a single diagram. Also, some other concepts will be encountered, which are not represented in Figure 1.

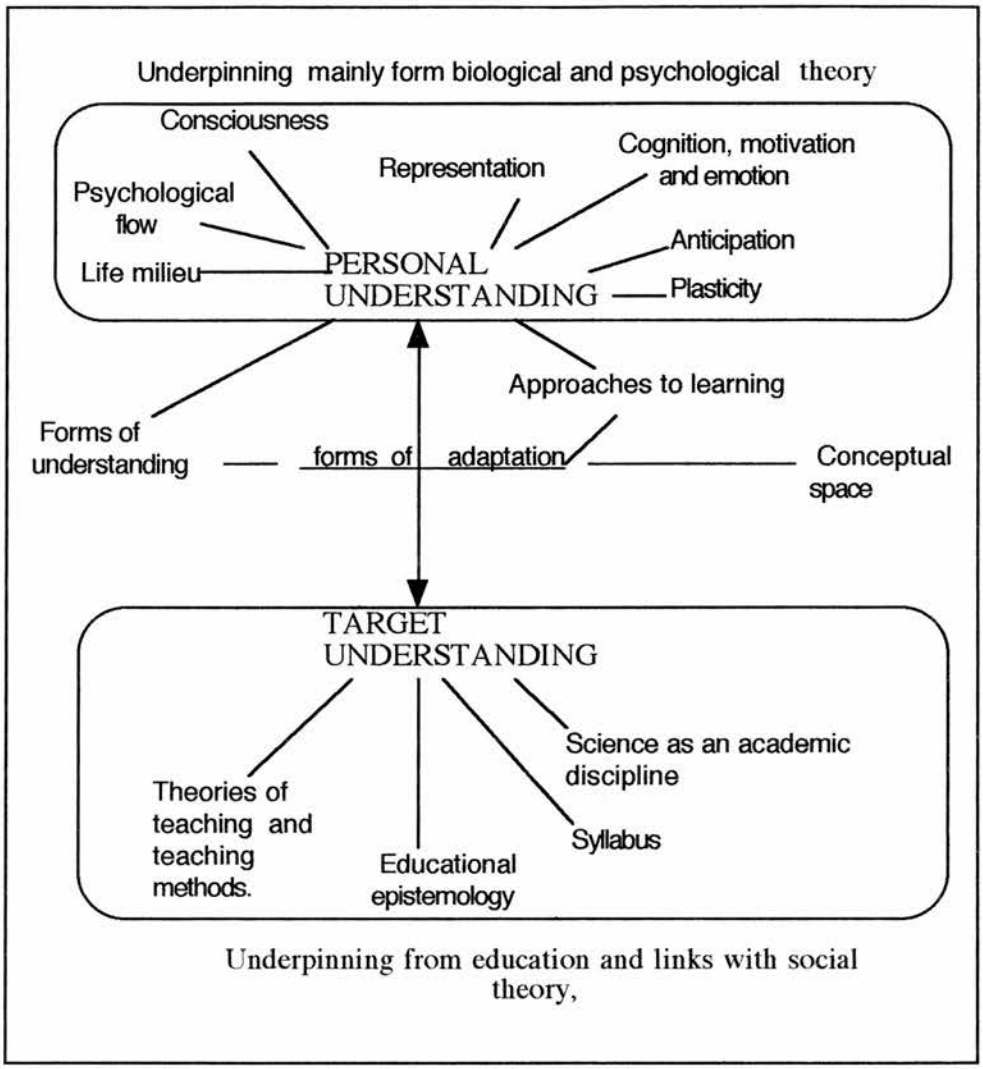
Before outlining the progression of the thesis through these concepts, it may be useful to some readers to give a background based on firstly, a brief description of changes in Scottish education and, secondly, on some of the more general developments in thinking which seem to push towards a more urgent development of the concept of understanding.

Some background in Scottish practice.

Education in Scotland has been undergoing a relatively prolonged period of change. which gathered pace between 1977 and 1987 (Gatherer, 1989). The main change has been away from more teacher-centred educational strategies and towards more student-centred (or pupil paced) approaches. This was accompanied by a shift in assessment philosophy and practice from a norm-based to a criterion-based approach (see, for example, Pilliner, 1979; Black and Dockrell, 1984). Criterion-based assessment involves

....the declaration to pupils and teachers of the level of achievement to be expected in each topic included in a course, and the specification of ways in which pupils are expected to demonstrate their achievement. (Kellington, 1979)

Since 1987, developments have continued apace, with national reforms to the curriculum for 5-14 year old pupils, following a government paper (Secretary of



Educational explanation within a hierarchy of disciplines

FIGURE 1: IMPORTANT CONCEPTS IN 'UNDERSTANDING UNDERSTANDING.'

State, 1987) which are still being implemented, and, more recently, proposed reforms to the curriculum for 16 - 18 year old pupils (for example, Higher Still Unit, 1995). Developments look set to continue into the next millennium, with the publication of an important discussion paper (SCCC, 1996a) on the nature of effective teaching and learning, which aims to bring the flavour of current thinking and evidence from research to the attention of teachers. A number of principles for effective learning and teaching are stated in this paper, but there is no indication as to why these, and not others, are derived from the research literature. Also, the school inspectorate (H.M.I., 1996) has published a document of performance indicators. These derive from the inspectors' interpretation of what counts as the good practice they have observed in schools, but there is little overall rationale provided as to why they are interpreted in this way. Specifically, there is no indication of how these performance indicators relate to research based observations of teaching and learning.

It would be useful to have a more systematic way of linking the research literature and its ideas to educational practice. This should serve to give a more secure theoretical basis to educational practice, and also to give greater precision in controlling the direction of the latter's development and change. The above documents acknowledge the importance of understanding in a general way, but there is little or no systematic attempt to explore its nature. It is a claim of this thesis that an analysis of understanding provides the means to a more orderly link between research based theory, curriculum development and classroom practice.

Other recent developments.

Several other recent developments of a more general or theoretical nature can be identified, and which combine to justify the further exploration of the concept of understanding to bring explanation and instruction more closely together. This can be seen as providing the impetus for the analyses of the literature which form the basis of this thesis.

a) A useful conceptual description of the background shift in thinking which has accompanied the above developments in Scottish education, and similar ones in other countries, has been made by Wolf and his colleagues (1991). They describe a shift in 'educational epistemology' from an 'epistemology of intelligence' to an 'epistemology of mind' - a movement away from an emphasis on ability to an emphasis upon individual achievement. This change suggests a need to deal conceptually and practically with individual, and perhaps idiosyncratic, ways of understanding.

b) Recent theories, such as constructivism, have emphasised that individuals interpret contexts differently, on the basis of their own goals, motivations, knowledge and past experiences. Paris and Byrnes (1989) suggest that constructivism depends on or leads to intrinsic motivation to seek information, understanding that goes beyond the information given, mental representations which are developmental, progressive refinements in levels of understanding, and reflection and reconstruction in learning. Whether or not we accept all these components, they do suggest a need for a more thorough analysis of individual understandings and their relationships with educational aims.

c) Another theoretical approach which emphasises individual interpretation of context originates in studies of approaches to learning (Marton and Säljö, 1976a, 1976b). Different conceptualisations of a task and associated perceptions of task demands, lead to difference in the way in which that task is approached.

Just how explanatory and instructional issues can intertwine and develop together can be illustrated by considering Marton and Säljö's category of 'the deep approach.' which depends on an 'intention to understand'. Here, the meaning of both understanding and intention become problematic, along with questions of what we actually want our students to gain from their education. Such thinking can move all too easily from the explanatory to the instructional , without any clear indication of how they relate, or of how various concepts fit together. While this line of research pushes us towards analysing understanding, it will also raises some of the issues and concepts which need further clarification.

c) Further relevant issues were derived from a workshop on 'understanding understanding', which were raised in the concluding session by Nisbet (1990).

- *Is understanding an act, an event, a state, a process?*
- *Is understanding an activity, an intention, an outcome?*
- *What competencies does understanding have associated with it - retrieval, application, transfer?*
- *How far is understanding generalisable/context specific?*
- *How far is understanding a stable or a changing phenomenon?*
- *How does understanding relate to learning and knowledge?*

d) Finally, there is another set of issues which stimulated the exploration of 'understanding' and which have to be taken into account in considering how it is to be conceptualised. What are the contributions that academic disciplines make to human understanding or the interpretation of self and the world? In the context of this thesis,

this question requires some consideration of the relationships between a discipline and the way in which it is taught in educational institutions. For example, are pupils 'real' scientists or apprentices taught in a context alien to both their everyday world and to real science (Claxton 1991)? Does the activity of science arise out of our general cognitive processes and so have a natural relationship with cognitive functioning (Rubinstein *et al*.., 1984)? That is, in teaching science, are we developing natural thought processes? These types of educational issues relate to questions regarding the individuality or uniqueness of understanding and of shared understandings (or shared ways of gaining understanding) between groups of people. To what extent can individual understanding be unique and still be shared? To what extent can shared understanding in one context be different from a shared understanding in another context, but still be said to be related? To what extent can individual and shared understandings in an initial context be different from individual and shared understanding in a second context, but still prepare a person to shift from the first context to the second?

Towards a strategy

Although they provide a justification for seeking to develop a concept of understanding which links explanation and instruction, and to provide some guidelines for which issues need to be taken into account, the list is daunting. A single thesis could not deal adequately with them all. Thus an alternative approach is needed. It may be possible to develop a concept of understanding which leaves open the possibility that different perspectives can be applied in its future elaboration. If different perspectives on the nature of mind and on intellectual development are only partial stories (Cobb, 1994), then different perspectives on understanding are equally likely to be incomplete in isolation, but they may be complementary when taken together. What needs to be avoided is a limited definition of understanding. As White and Gunstone (1992) argue

Simple definitions of understanding are partly responsible for the current limited appreciation of understanding in teaching, learning and assessment. An extensive description of understanding is to be preferred. (pages 2 - 3)

The main argument of this thesis is intended to provide a more extensive description of understanding which will be useful to both educational research and practice. Of course, many writers have tried to link theoretical or researched based terminology and findings to educational practice and these are often successful. For example,

Nisbet and Shucksmith (1984,1986) have examined the role of metacognition in educational learning, providing insights which have been widely quoted in inservice courses. The literature on science education contains ideas drawn from both cognitive science (eg Carey, 1989), and constructivism (eg Driver, 1989; Gunstone and White, 1994), and their influences can be detected in much of what is now suggested to be good educational practice (see, for example, SCCC, 1996a, 1996b). However, although these influences can be detected by the 'initiated', the argument will be made that there is a lack of coherence in current instructional theory, which derives from the lack of an overall explanatory framework for educational learning.

The importance of understanding as a research topic or concept has also not been missed. The nature of understanding has, through the last decade or more, received increasing attention in educational research. 'Understanding' has progressed from being a word used to express the aims of research to being a term referring to a phenomenon worthy of research interest in its own right. Furthermore, this interest in understanding as a phenomenon is not restricted to particular research traditions or schools of thought. It is possible to cite authors from a number of different backgrounds and perspectives who have given prominence to descriptions and explanations of understanding in educational contexts - for example, Egan, (1991), Gelman and Greeno (1989), Gardner (1993), and Perkins (1997) in America; Entwistle and Entwistle (1991 a and b), Ormell (1984), Skemp (1979), and Svensson and Gerrevall (1991) in Europe; Biggs and Collis (1982), Burns *et al* . (1991) Prosser (1990), and White and Gunstone (1992) in Australia and New Zealand.

However, it will be argued that there is still a need to distinguish further and to develop an explanatory theory of understanding, which can then be used in developing the ways in which educational practice is governed. It will be argued, that while that explanatory theory needs to be specific to education, it also needs to attempt to be consistent with findings in other academic domains. The above discussion also suggests that it needs to bring together concepts which allow us to describe and specify the content and activities of our educational provision more fully. Up to now, various areas related to understanding appear to have been discussed separately and without a clear distinction between explaining phenomena in learning and providing guidelines for instruction.

The framework for thinking about understanding in educational contexts which is developed here is intended to be general to various contexts in education. However, it is also aimed at making it possible for research to approach the phenomenon from different directions - 'bottom up' and 'top down'. In this way, different perspectives

are brought to the topic, and overly simple definitions of understanding are avoided. However, there are some cautions which are worth noting at his stage.

Firstly, in dividing up the overall picture, a researcher has to make limiting assumptions as to what is important in explaining understanding in a particular research context. Care will have to be taken clearly to state the limits within which any explanation of understanding is intended to be valid.

Secondly, the nature or rules of explanation of phenomena may vary, depending upon the interest and theoretical background of the researcher. Furthermore, the framework uses the term understanding in more than one way. The reader may not be immediately at home with all of these uses. However, it is hoped to show that at a level of explanation appropriate to education, these senses of understanding have meaning and are an essential basis for the comprehension of the phenomenon of human understanding in educational contexts, and enable educational explanation to be set within other contexts of explanation.

That educational explanation needs to be set in a broader context derives from the nature and purpose of educational practice. Any educational setting, whatever approach to education it uses, aims to prepare people with previous sets of experiences for future sets of experiences. It is, therefore,inevitably set in a broader context. A context which includes cultural and social norms, expectations and purposes. A conception of understanding needs to help us to take account of that broader context. At the same time, it is not always possible or necessary to describe the full contexts in which an explanation is set. Nevertheless, there are also occasions when a restriction to too narrow a context of explanation leads to a limited description and definition of the phenomenon concerned. We have noted that a limited definition is something to be avoided. There is, what Scharfstein (1989) calls, the 'Dilemma of context' - the need to respect context, but only within reasonable limits according to our aims which are never neutral.

A context is by definition, relevant to whatever it is that one wants to explain and excludes everything, no matter how close in some way, that excludes explanatory power. (page 1)

However, to avoid limited definitions, we need to show how contexts of explanation relate to each other. Representing the relationships between the contexts of explanations which are based on different approaches to thinking about understanding and related issues is not easy. It is hoped that the framework developed in this thesis, and the concepts discussed in this development, at least stimulate further argument

and discussion as to how best to achieve this when explaining understanding in educational contexts. Thus, the overall strategy for meeting the aims of the thesis is to work towards a concept of understanding which;

a) draws on and integrates various areas of research related to understanding.

b) distinguishes explanatory theory from instructional theory, but which relates them in such a way as to make their mutual development possible.

c) can be developed further as the influences on understanding in educational contexts continue to be researched and debated.

The argument in outline

The central idea in this thesis can be stated quite simply.

Understanding is best thought of as being a range of possible relationships between personal understanding and target understanding.

Chapters 2 to 5 will lead the reader towards this central idea, and place it in a context derived from both educational practice and a range of academic disciplines. Educational theory is seen as having a place in a hierarchy of explanatory disciplines in which the constraints on theory development operate upwards and downwards. Chapters 6 and 7 will develop the concepts of personal understanding and target understanding and attempt to show their relevance to both theory and practice. The final chapter will defend the central idea from a slightly different perspective. It will be suggested that the central idea brings together many concepts in a useful way, that it can be can be used to formulate research hypotheses which are useful in theoretical terms and the testing of which have relevance for educational practice, creating the potential for very practical improvements to teaching, learning and assessments.

Chapter 2 will begin by exploring what seems to be the current function of a concept of understanding in educational practice. It will look at the ways in which the concept is becoming more relevant, with a resulting pressure to come to grips more systematically with its nature and its conceptualisation. Although it is not clearly defined in educational practice, the concept of understanding already has an influence in this context. Clarifying the concept would help us to ensure that this influence is positive.

Chapter 3 will begin to examine the nature of a concept of understanding which can meet the needs of educational practice and theory. Beginning from a more theoretical perspective than chapter 2, it will look at ways of thinking about the biological and contextual constraints upon a person's development, and will place educational explanation within a hierarchy of levels of explanation. Bereiter's (1991) distinction between explanatory theories and instructional theories is introduced as a starting point for considering the complexity of explanation in education. Two important conceptual issues are considered at this point. Firstly, understanding as being a form of Intentionality.[1] Based upon an analysis by Bechtel (1988), a viewpoint is taken which allows the combination of analyses of internal processing views of understanding and external, environmental views. This leads to the second conceptual issue - a consideration of understanding as being a form of adaptation. This form of adaptation applicable to understanding is considered in relation to the biological concept, and is found to be more complex.

Chapter 4 takes up the conceptual specifications from Chapter 3 and seeks to relate them to some of the current conceptual developments in biology and psychology. It is suggested that understanding, as a form of adaptation, has a basis within biological plasticity and, within the species specific biological and psychological structures and mechanisms of human beings. The relevance of representation by the brain or mind for a concept of understanding is also considered from both biological and psychological perspectives. A view of personal meaning emerges which is basically in line with constructivism, but which is constrained by both internal processes and context. At this point, a number of concepts which have been discussed or developed in these three chapters are brought together within an initial framework which aids thinking about educational theory and practice. A framework in which outcomes of education can be described in terms of the idea of *forms of understanding* (Entwistle and Entwistle, 1991a, 1991b).

Chapter 5 builds upon the themes and concepts identified in the previous chapters. These themes constitute the foundations for a framework for thinking about understanding which incorporates the key idea of relationships between personal understanding and target understanding. Starting with a simple analysis of how understanding is used in various linguistic contexts, the distinction is made between the concepts of personal understanding and target understanding. Personal understanding is a description of understanding from the perspective of the individual, and it develops not only within the immediate context, but also through the whole life

[1] There is a convention adopted here in which 'Intentional states' and 'Intentionality' are spelt with upper case 'I' to distinguish the terms from 'intention' which is just one Intentional State or form of Intentionality.

milieu of the person. It is a concept at the educational level of explanation which allows the researcher to incorporate the ideas of adaptation discussed in the previous chapters.

Target understanding is a concept which allows us to discuss contexts in terms of understanding. It is also intended to help in thinking about the ways in which educational contexts are embedded in broader contexts, and to allow us to specify the context to which we are referring, and the limits within which we are discussing understanding. This helps us to be clear when we are discussing understanding in terms of educational goals or values (instructional senses) and when we are discussing it in explanatory senses. A full explanatory conception of understanding involves seeing understanding in terms of a range of relationships between personal understanding and target understanding, and in seeking answers as to why that range exists. This is the basis of a framework for understanding understanding, which allows the learning outcomes to have their origins within both individuals and the contexts of their life milieux.

This way of thinking about understanding eliminates some of the mystery or confusion about the concept - suggested, for example, in discussions about when a way of thinking is understanding and when it is not. However, it does make use of particular meanings for the term 'understanding' which need to be justified.

Chapter 6 attempts to give the concept of personal understanding more substance. Since personal understanding is an educational concept which is explanatory at the level of the person, it has to be related to other individual characteristics. Thus, the relationships between personal understanding and a number of psychological concepts and issues are explored.

It proves difficult to encapsulate a concept of personal understanding in a simple definition as it covers a complex area of explanation. This complexity only resolves itself into greater clarity when personal understanding is considered relative to a particular context of explanation. However, it does prove possible to outline a number of principles which apply to the concept of personal understanding. This set of principles, or features, may not be comprehensive, but do serve to make the concept meaningful. Some advantages of accepting the concept are also suggested.

Chapter 7 deals with the concept of target understanding. At first sight, this may seem a more straight forward concept than personal understanding, but, nevertheless, there is at least one complicating factor. For a particular individual in an educational

context, the target understanding presents itself, in part at least, through the personal understandings of others. A model of target understanding must incorporate this aspect while seeking to clarify the relationships between target understanding and contextual features of the environment. It must also seek to position the relationships between explanatory and instructional theories. The way in which educational target understandings can be communicated is examined, with the focus on language and texts. The nature of science texts as a target understanding is considered. Various forms of text in syllabuses, text books and coursework sheets, dialogues between pupils and teachers, are seen to act as intermediate interpretations between target understandings in an academic discipline and the development of pupil's personal understanding in relation to that discipline.

The chapter culminates in a model of target understanding which indicates how influences derive from the syllabus and the subject of study on which it is based, and also from the general aims for education as perceived by both educationists and society in general. Moreover, it draws attention to the communication or negotiation of personal understanding, with the model of educational target understanding. It is suggested, that this model is able to bring together explanatory and instructional theories into a mutual relationship, which was one of the main aims of the thesis.

Finally, Chapter 8 tests the status of the framework as a theory of understanding. An outline diagram of this explanatory framework is presented, which indicates the relationships between some of the main concepts discussed. It is an outline model since it is difficult to clearly show in diagrammatic form how all the relevant concepts fit together. Other concepts in the original outline in Figure 1, while remaining important for explanation, form a background to the concepts shown in the explanatory framework. It is suggested that one approach to describing the theoretical status of the framework is to begin by stating the key idea more strongly in the form of a core hypothesis. A core hypothesis, by definition, cannot be directly tested, but it is open to more indirect testing, which can be both analytical and empirical. Two main criteria are used.

- The way in which the explanatory framework derived from the core hypothesis integrates and synthesises concepts into a more convincing description of the nature of the phenomenon to which the core hypothesis is directed.
- The derivation of hypotheses which are specific to aspects of the framework and which are open to empirical test.

Both of these criteria are applied to the explanatory framework which is developed in

this thesis. Its potential value is found to have a grounding in these two areas. Some suggestions for how aspects of the explanatory framework may be empirically tested are given. Two more criteria are also applied. In addition to the analysis carried out in the previous chapters, the framework is compared with the performance view of understanding (see, for example, Perkins, 1997) and is found to avoid some of the problems inherent in the latter. Finally, the use of the framework in incorporating relationships between explanatory theory and instructional theory is discussed in relation to some recent documents in Scottish education.

The starting point of the more detailed examination of the issues outlined in this chapter is a consideration of the ways in which the term 'understanding' is currently used in educational practice. From that, we move on to a review of the research evidence and theory from a number of different perspectives, always with the aim of teasing out the core 'meanings of 'understanding'.

Chapter 2
The Place of a Concept of Understanding in Current Educational Practice

Understanding has possibly always been a central concept in educational practice. However, it has not been, until recently, perceived as being a problematic concept. It will be argued that conceptualising understanding derives a more pressing relevance from this perception of it being problematic. The interdependence of the research issues referred to in Chapter 1 also become more evident if we consider why conceptualising understanding seems to be more problematic, or important, than it was previously thought to be. The ways in which people working in education think about understanding are gradually changing. These ways of thinking make the teaching of understanding seem to be more of a problem. It then becomes relevant to try and deal with the problem. At present, the problematic nature of the concept of understanding appears to be most clearly felt in research, but it is hoped to show that it also derives as much from educational practice.

In this chapter, we begin by looking at how some teachers use the term 'understanding', before examining its place in curricular documents as an important aim of education. The emerging emphasis on understanding will then be described as reflecting a change in educational epistemology from an epistemology of intelligence towards an epistemology of mind (Wolf *et al.*, 1991). This will then lead to a more theoretical analysis in the following chapters.

Teachers tacitly use a concept of understanding.

To begin with, understanding is already a term used in the everyday vocabulary or terminology of educational practice, and it has been for some time. It has long been common to hear teachers use phrases such as - "Do you understand?" "Pupils find this difficult to understand" - among others. However, when asked directly what they mean by "being able to understand", teachers find it difficult to provide a clear or/and common answer. The following small selection of responses from teachers show some of the variations in how understanding is conceptualised. It should be emphasised that the data does not represent a serious study of teachers' conceptions of understanding. It was gathered in an informal attempt to gain some background insight into how teachers from a range of subjects, but who mixed socially, conceived of understanding.

Teachers' written responses were given to the following question:

"If someone has a good understanding of my subject this means that ....."

Teachers of Mathematics

"they can understand the question and complete it satisfactorily."

"he/she has a good grasp of the skills appropriate at the particular level and can apply those acquired skills in problem solving applications."

he/she can think logically, count and solve problems."

" his knowledge of Maths would enable him to proceed to do Higher Maths or be able to do this level of maths if he wished."

Teacher of Music

"he has a good general knowledge of music both historically and grammatically/theoretically."

Teacher of English

"he has knowledge and awareness of mechanisms, rules and uses of language both spoken and written, plus a knowledge and awareness of some aspects of literary forms."

Teachers of Chemistry

"he has a good understanding of chemistry in that he has gained a lot of knowledge about the subject and is able use this to solve problems."

"he/she is able to apply his/her knowledge to a similar set of circumstances with confidence and clarity."

Teacher of French

"he can understand what is being said to him in French, he can communicate in French with someone else, and he is able to read/study the language independently of the teacher."

Teacher of History

"the pupil has mastered the body of knowledge taught, understood the methodology used by historians to reach conclusions about events in the past, ie skills of enquiry and deduction, and has understood the concept of time."

Although not based on a representative sample, these comments nevertheless serve to provoke some initial speculations and assumptions.

Jones (1986) argues that science education - even when aimed at pupils raising and solving their own questions - progresses in a predetermined framework not unlike the paradigms discussed by Kuhn (1970). Pupils are expected to formulate and answer questions within this paradigmatic framework. It seems from some of the above teacher responses that science may not be alone in this. Understanding is successfully doing what the syllabus predetermines in terms of acceptable questions and answers. Without this syllabus based-framework, pupils presumably are not seen to have an understanding of the science discipline, or the subject matter it deals with.

Another strand of thinking may be implicit in the above teachers' comments. There is an implication that understanding can be prescribed, tasks derived from the prescription, and pupil successes at these tasks then indicate that understanding has been achieved (see also Biggs, 1990). Contrast this view with the following. Kochen (1975) argues, in a way which precedes the concept of metacognition (eg Flavell, 1976, 1981; Nisbet and Shucksmith, 1984, 1986), that understanding can be described as going beyond knowledge, as it reflects the comprehender's awareness, not only of what he knows but also of what he does not know and needs to know and how these interrelate. Understanding can be determined by the depth and perceptiveness of the questions asked by the comprehender. Since a syllabus, by definition, prescribes certain activities and content, it cannot - if Kochen is correct - predetermine exactly what understanding is reached. Individuals will always have different prior knowledge and so they will have different ways of using (or not using) the provisions made by the syllabus as they develop their own understanding. That, of course, is not the same as saying a syllabus cannot be constructed to facilitate the development of understanding. This distinction will assume greater importance later in the thesis.

Clearly the validity of teachers' apparent conceptions of understanding needs further examination. Do we need to take account of alternative views? The tacit views of teachers determine much of what they do in teaching, and the tacit views held by advisors and syllabus writers, for example, also lead to constraints upon how the educational system operates. It would seem pertinent to investigate the operation of these tacit views for that reason alone.

Students and pupils also have tacit ideas about understanding. Any teacher will have seen pupils attempting to grasp some complex conceptual topic by trying to memorise or rote learn chunks of notes or textbooks. Some teachers may have asked if the pupil concerned understands the topic and be answered in terms of, "yes," if memorisation has been successful, or, "no," if rote learning has not been achieved. Since concepts

of understanding also determine what learners do, this is a further relevant reason to research it.

We can make the assumption that a common framework for thinking about understanding, based upon a thorough research and analysis of it as a phenomenon, would help all of us in education (educationalists and students) to focus more effectively upon our goals, teaching/learning methods, and teaching/learning difficulties. In particular, we may reach a position where we are better able to help our students to determine what their aspirations should be for coping with their own unique sets of circumstances.

Understanding is already an aim of education

Understanding is a prominent term in documents setting out the aims of schools and courses. One might expect therefore some clarity as to its nature. The above discussion suggests that if this clarity is evident in the documents, then it has not necessarily filtered down to teachers and learners. Just how clearly conceptualised is understanding within the administrative documents of education?

The curriculum in Scottish Secondary Schools is currently founded upon - and at a general level evaluated against - a set of guidelines produced by the Scottish Consultative Council on the Curriculum (SCCC, 1989). This set of guidelines is not directed at setting out the fine details of organisation and management of the curriculum at school and organisational level but, rather, it aims to provide a framework for resolving the competing claims made by the changing aspirations of society and the needs of individual pupils. This framework is described as having arisen from widespread consultation between various government and other bodies representing educational and industrial interests, employers, education authorities and parents, but is not seen as being final. As circumstances change, the framework is intended to allow for changes in the curriculum. However, the pressure to conform to the framework as it currently exists is strongly felt at school level - a possibility predicted by Gatherer (1989) - leading to it being nicknamed the "Yellow Peril" (due to the colour of its cover).

The document begins by describing the curriculum in terms of the national framework, local provision and individual curricula and derives a rationale and set of claims on the curriculum from these. From this rationale and set of demands upon the curriculum, a set of general curricular aims is derived.

- *the development of* ***knowledge and understanding;***

- *the development of a range of* ***cognitive, interpersonal skills and psychomotor skills;***

- *the affective development of pupils in a whole range of* ***behavioural attitudes;***

- ***preparation for life and development of social competence.***

(SCCC, 1989, p. 7, original emphasis)

The document has little more to say specifically about understanding. In a section entitled 'Demands of knowledge', the SCCC notes that education in our culture is closely associated with the development of knowledge and understanding, and states that each category of knowledge has its own distinctive skills, concepts, logical structure and methodology. It is also said to be an expectation in this culture that all pupils experience each form of knowledge to some degree. We might assume, therefore, that understanding is something that grows, as our experience of these categories of knowledge increases. Questions about what exactly that 'something' is, and whether it grows in the same form (as opposed to the same degree) in all pupils, do not appear to be considered, although these questions are implicitly contained within the other general aims. We find ourselves asking the same question which emerged from teachers' tacit concepts of understanding. Does "having understanding" go beyond having knowledge and, if so, in what way?

It would be an interesting exercise to examine the wide range of documents associated with the various forms of knowledge in the curriculum to see how far the claims for consistency with the SCCC framework are in fact in evidence, and if a clearer answer to our question arises. However, this would become a thesis in itself, and so this exploration will be limited to science education, with particular reference to biology.

Scottish Science Education in the middle secondary school years currently comprises certification at Standard Grade Level in one or more of Physics, Chemistry or Biology, or alternatively in Science. The latter is intended for those of lower scientific ability or for those who have chosen to specialise in other areas of the curriculum, but who must still undertake a science course in order to meet current statutory requirements.

The aims of the courses are similar and correspond to the general aims of the SCCC (1989) being, in the case of Biology, the acquisition of:

1) Knowledge and understanding of some biological facts, ideas and techniques; some

applications of biology in society.

2) Skills in problem solving by handling and processing information; evaluating procedures and information; drawing conclusions and making predictions.

3) Practical abilities associated with investigations in biology.

4) Positive attitudes, such as being open-minded and willing to recognise alternative viewpoints, having an interest in Biology, in themselves, in their environment, an awareness that they can take decisions which affect the well- being of themselves and others, and the quality of their environment.

(SEB, 1988, p7)

The four science Standard Grade courses are essentially designed in a single format. They are divided into topics in terms of various learning activities which are aimed at contributing to the achievement of aims 2 and 3, as well as contributing to knowledge and understanding. Teachers are informed that any alternative learning activities, which they may choose to use, should contribute to the same ends. 'Knowledge and understanding' are described in terms of Grade Related Criteria (see for example, Black and Dockrell, 1984; Drever, 1988, Pilliner, 1979) for each topic to be studied. Aim 4 seems to have no further mention.

Some key terms are defined for use in the Grade Related Criteria: *state, give examples, identify, describe, explain.* From their definitions, only the final two seem to refer to anything other than what may be achieved by rote memorisation. A Grade Related Criterion using the term 'describe' requires that:

Pupils should be able to give or complete an account, in writing or diagrammatic form, in such a way that the description may be understood. (SEB, 1988, p. 9)

Understood by whom? The reader or the pupil? Are we being asked to assume that the pupil understands if the reader understands the pupil's description? This is an important point, as will become clear later, when we begin to unravel the meaning of understanding.

The definition of 'explain' also refers to understanding, indicating that pupils should be able to

illustrate the meaning of the word or concept in words and/or diagrams;

answer correctly an item which tests understanding of that idea;

give full reasons;

classify, compare, distinguish between, or list examples of ideas and concepts.
(SEB, 1988, p9)

What does this mean in practice? One Grade Related Criterion is:

State that digestion is the breakdown of large particles of food into smaller particles to allow absorption into the blood stream through the small intestine wall. (p. 9)

Success at this indicates a General Level learning outcome for this part of the topic. A Credit outcome adds the following to the above:

Explain that digestion involves the breakdown of insoluble food substances into soluble food substances. (p. 18)

An assessment item for this criterion is:

Briefly explain what is involved in the process of digestion. (SEB, undated)

The pupil has six lines of space to respond. An examination of other criteria and assessment items gives the same picture. It is difficult to find any questions for which pupils will not already have a 'potted' answers in their notes. It therefore seems that understanding will be adequately shown if the pupil can give back either the statements in the Grade Related Criteria, or some simple rewording that the teacher has given. Understanding - in this context - is simply a growth in the knowledge of biology along the lines laid out in the syllabus document.

This could be seen as an acceptable educational practice for pupils of this age. It could also be a fair argument that engaging pupils in this way is a prerequisite for developing the real understanding which follows with greater maturity. However, Simpson (1988) apparently thinks that this is not the case. She notes that the contents of Standard Grade course texts and teaching materials do not teach concepts, but instead present a wide range of information with the assumption that pupils will derive the concepts for themselves. Simpson notes that a close scrutiny of secondary courses by researchers reveals that they are

rich in anomalies, contradictions, gaps and other traps for the innocent learner. (p 31)

Without having a conceptual framework in place, the pupil has difficulty in reconciling information from one part of the syllabus with information from other parts. At best,

this would seem a wasteful pathway towards developing understanding.

One notable feature of the way in which the Standard Grade Sciences are assessed is the separation of 'Problem solving' and 'Practical activities' from each other, and from 'Knowledge and understanding'. It seems that they can contribute to the development of knowledge and understanding, but knowledge and understanding do not contribute to them. Problem solving abilities and practical skills are practised in the context of acquiring knowledge and understanding but are independent of knowledge and understanding. Also, as we have seen above, knowledge and understanding as defined here can be acquired without necessarily engaging in the other two. It is as if the model in Figure 2, has been used in designing this syllabus.

At least one alternative model, which uses the same three components, could form the foundation for constructing the course. The model in Figure 3 conceives of understanding as growing through interactions of increasing knowledge and developing levels of problem solving abilities and practical skills.

If we used the second model, we would probably come up with a different syllabus and form of assessment. There may be other possibilities. It is not the claim here that either of these is correct, although the second model would appear to be more consistent with the SCCC statement that each knowledge category has its own methodology and skills, and so on. Also, it seems that the syllabus designers of the courses proposed to replace the current Higher[1] may have, tacitly at least, adopted something similar to Figure 3 with an acknowledgement of the difficulties of separating problem solving assessment items from knowledge and understanding items in assessments. In practice, it is often difficult to decide if an item involves problem solving, or knowledge, or some sort of combination. Consequently, attempts are now being made to develop what are referred to as 'holistic tests', in which the aim is to cover all the aims of a topic in the test as a whole (Higher Still Unit, 1997a).

However, a recent document on the future of science education (SCCC, 1997b) lists five different aspects of scientific capability. One of these is scientific understanding. The others are scientific curiosity, scientific competence, scientific creativity, and scientific sensitivity. The authors provide lists of learning outcomes associated with each. It is not clear if it is proposed to develop separate assessments for each of these - the group does state that the aspects are separate but connected, yet no clear model is

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[1] The level of course taken after Standard Grade which leads to a qualification at around age 17.

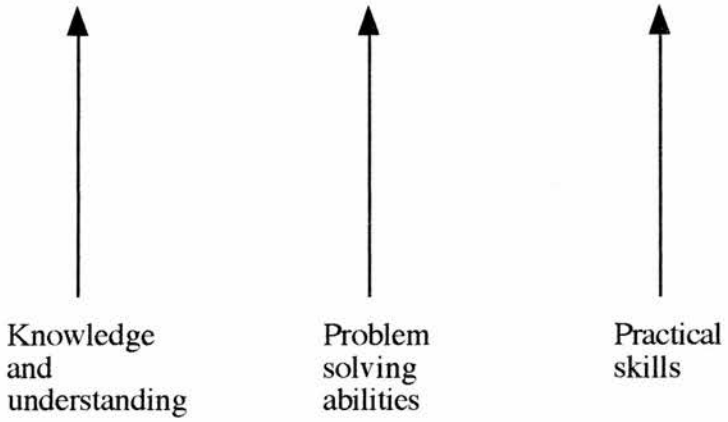

FIGURE 2: A MODEL OF SEPARATE DEVELOPMENT OF KNOWLEDGE AND UNDERSTANDING, PROBLEM SOLVING ABILITIES AND PRACTICAL SKILLS

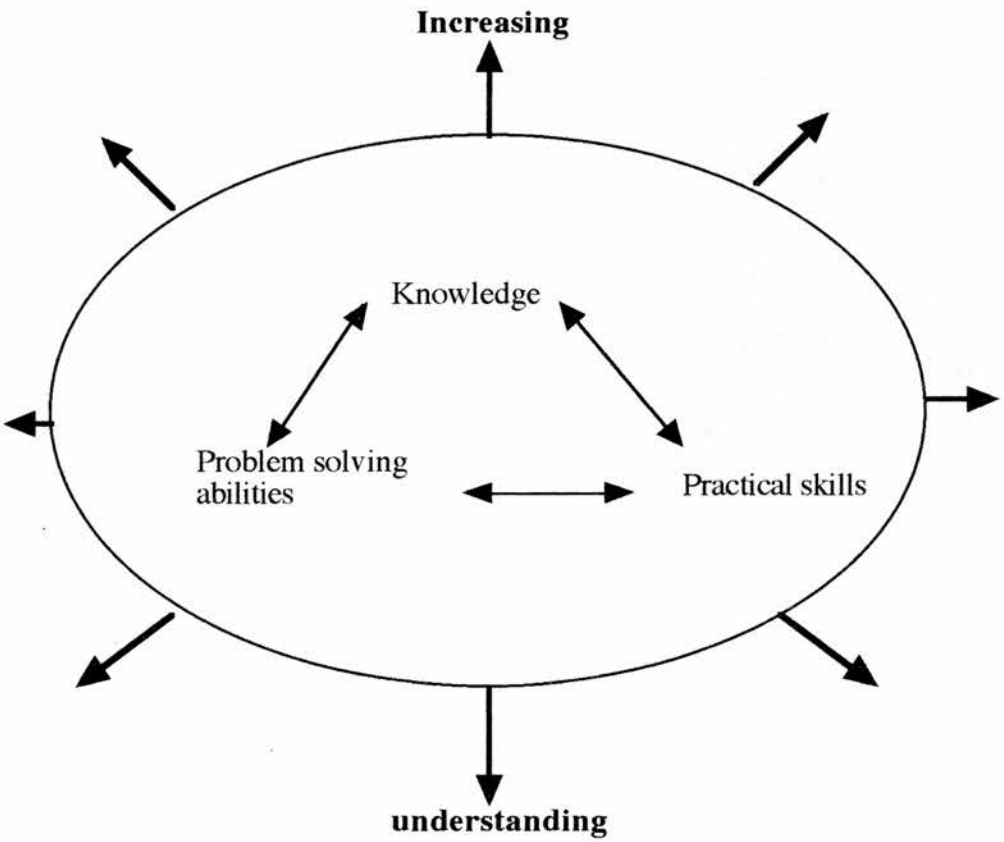

FIGURE 3: A MODEL OF DEVELOPMENT OF UNDERSTANDING THROUGH INTERACTION OF KNOWLEDGE, PROBLEM SOLVING AND PRACTICAL SKILLS

offered of how they are connected.

What the above does show is that conceptions of understanding can influence the way in which we operate our curricula, and that it is not satisfactory to allow these conceptions to remain in the background to our thinking as educationists, if we wish to be more certain of our rationales and methodologies.

If we attempt to explore further what educationists mean by understanding when they use the term in various documents and texts to do with the syllabus or tackling particular issues, we continue to find a lack of formal clarification and are left to look for implied meanings and characteristics. A slightly different perspective from the above discussion, is offered by the 5-14 documentation (see for example, SOED, 1993), which seems to imply, but again does not formally state, that understanding is a form of personal growth. Certainly, personal growth is seen to be the result of experience, broadening out from a focus primarily upon oneself into broader and broader contexts. In social education, we may imply that understanding is a comprehension of self and others, along with a growth in tolerance of differences, ability to resist peer pressure, and so on (TACADE *et al.*, 1986). If we read literature on differentiation of learning according to pupil differences and needs, we find that understanding is mentioned as something which facilitates or hinders learning but without any further clarification (eg. Postlethwaite, 1993).

Scotland is not alone in the United Kingdom in not having clearly enunciated what is meant by understanding. The National Curriculum in England and Wales also has no formal clarification of the term or aim and a variety of interpretations are also possible (Dobson, 1989); New Zealand likewise (Burns *et al.*, 1991). In the case of America, a national trend cannot readily be discerned. However, there is at least one major research study which is engaged in simultaneously analysing understanding and teaching for it (Gardner *et al.*, 1991-92, 1992-93, Wiske, 1997). We are reminded again of the quote which opened Chapter 1.

If understanding is a primary goal of education, an effort to understand understanding would seem to be an obligation even if one is convinced that it is likely to be only a partially successful effort. (Nickerson, 1985, p217)

As researchers and writers from different disciplinary backgrounds have tried to take up this challenge, the chances of having a larger measure of success have increased. This, in turn, makes the attempt to understand understanding still more pressing. There is also another, not unrelated, pressure to be clearer about understanding - the shift in epistemology within educational research and practice.

An 'Epistemology of Mind' focuses attention on understanding.

In recent times, there have been a number of important changes in conceptions of basic educational activities. Perhaps these changes are most manifest in assessment, which is no longer seen as being solely a tool for sorting people into social roles for society, but rather it is thought of as an activity which - in various forms - can be used for fulfilling a variety of purposes (Brown, 1988). In general, these purposes ensure a closer relationship between the curriculum and assessment. They include diagnosis of student learning success or failure, motivation to learn, the provision of accounts of what the learner has actually achieved (as against placing them in a rank order), and the evaluation of courses and teaching (see also, Buckle, 1990). Associated with these changes in conceptions of assessment are equivalent changes relating to how to structure courses, the nature of ability and of knowledge, the activity of the learner, individual needs, and so on.

These changes in ideas about assessment, and consequent changes in educational practice, are also to be found on the other side of the Atlantic. Wolf *et al.* (1991) provide a conceptual framework which is useful in providing the flavour of the changes. They describe a shift away from an *epistemology of intelligence* towards an *epistemology of mind* . They describe an *epistemology of intelligence* in the following terms.

- Intelligence is a matter of relative position on a normal curve, not a matter of criterion-referenced achievement.
- Intelligence, or ability, is seen to be immutable - there are no kinds or varieties, only ranks.
- It leads to an education system arranged in a scalar fashion preparing people for their inevitable lot in life - only those at the top of the scale are introduced to the most complex skills, in other words, there is differential access to the curriculum.
- It gives rise to a concept of 'hard and soft' subjects - physics is hard and literature is soft.
- Theory building, the acquisition of concepts, and symbolic manipulations are seen as being more worthy than practical, situated, or commonplace problem solving.

Two quotes usefully summarise this educational 'epistemology'.

learning is the acquisition of information or skills that generate decontextualized knowledge. Translated into school terms, individuals know nothing until - or unless - they take up the particular brand of formal knowing prescribed by school.'(p39)

'learning was formally and explicitly envisioned as a linear sequence of acquisitions in which complex understandings are the result of the accretion of elemental, prerequisite learning that, it is assumed, eventually add up to a larger achievement. (p. 40, original emphasis)

It can be noted that, within this epistemology, is the view that understanding is simply 'built up'. The implication is that understanding is nothing but the acquisition of more and more knowledge (see earlier discussion of S Grade Biology and the views of Simpson, 1988). There is no hint that learners need to transform or organise this knowledge for themselves. Understanding is thus not problematical for educationists who are operating within this epistemology. It can also be noted that some of the current educational documents still appear to hold elements of this epistemology, even though they profess to be following the alternative one.

How can an epistemology of mind be described? Wolf and his colleagues see it as having the following characteristics.

- The capacity for 'thoughtfulness' is seen as being widespread - it is not just a capacity of the privileged few.
- Learning - at any level - involves sustained performances of thought and collaborative interactions of multiple minds and tools as much as the individual possession of information.
- Learners construct (rather than merely absorb) knowledge, because inference, observation, rule generation and theory building are open to all.
- It is not only in academic disciplines but also in everyday thought that problems are solved in sophisticated ways.
- A recognition that the teaching of what were once regarded as being immutable and inaccessible constituents of intelligence (eg. basic strategies for problem solving and reading comprehension) is now a possibility.

This epistemology is more complex and therefore a little harder to summarise by means of selective quotes, but the following may help to convey the essential meaning.

Learning does not take place in small linear increments but is better described as occurring in qualitative and uneven shifts in understanding.'(p50)

Learning might be better described as passing major milestones in the nature and organisation of knowledge and skills. Learning is the individual's understanding of how to apply what she or he knows.'(p50)

Understanding becomes deeper or more complex with the opportunity to witness other minds at work and under the pressure of intrusions, challenges, and differing versions of others. (p50)

Any individual has a range of knowledge and competence rather than some fixed level of performance. (p51)

It presumes that all learners have minds that develop with experience and teaching; it underscores thinking rather than the possession of information; and it recognises that minds function in concert with other minds and the tools their culture makes available. (p57)

One recent Scottish document (SCCC, 1997a) seems very heavily influenced by this type of epistemology and its assumptions, and this supports the view that educational theory and practice is shifting from an *epistemology of intelligence* towards an *epistemology of mind* .It then becomes clearer why questions regarding the nature of understanding are receiving more attention. Questions about understanding become intrinsically more interesting and challenging, as well as being relevant to both research and practice.

If understanding is more than an accumulation of knowledge, if it involves varieties of qualitative transformations, if it is influenced by a wide range of factors not just within the present context, but also from the individual's past and their own interpretations and goals, then both the study of understanding and its promotion by educational practice become more demanding and uncertain occupations. In short, the shift in epistemology which is being practised in education, gives both theoretical and practical relevance to thinking about understanding through the revelation of its problematic nature.

This shift in epistemology also brings into simultaneous consideration the links between all the actors in an educational setting - that is, the teachers, the students and the course writers. The student brings an understanding to the learning context (including understanding of the learning context itself), and this may either facilitate or hinder the transformations in understanding which the educationists who devised this context wish to bring about. In summary, the following questions are raised by an epistemology of mind.

- What are the qualities in understanding (eg, depth, complexity, consistency, questioning, etc.) which we wish to encourage?
- What are the qualities in understanding which are at present defined in our syllabuses and other official documents?

- What qualities in understanding are our students likely to bring to the learning contexts we set up?
- How do we encourage the sorts of transformations in the understandings our students bring so that they come to incorporate the qualities as outlined in, or seem to underlie, official documents? That is, how do we encourage the development of our students' understandings in line with the purposes of education?

Relevant outcomes for educational practice.

There are at least three outcomes of conceptual clarification of, and research into, the phenomenon of understanding which are relevant to those engaged in the practice of education.

- A clear and research based conception of understanding would support the further development and elaboration of any educational epistemology which underlies the provision of education.
- Indirectly through its influence on educational epistemology and, directly, as a concept in its own right, a clear and research based conception of understanding would enable more effective design and evaluation of the curriculum.
- A clear and research based conception of understanding would be a useful tool for teachers who wish to think more effectively about their goals, their teaching methods, and the difficulties experienced by their students so that they may better facilitate learning in the classroom, lecture room, or elsewhere.

These outcomes become clearer if we take a current concern in British education - that of 'differentiation'. In both Scotland and the rest of Britain, there is now a recognition that all pupils, from time to time, will have learning difficulties. These difficulties may arise from various types of individual differences which lead to contrasting ways of responding to the presentation of subject material by the teacher. Therefore, in any class (even those based on selection by test performance), the pupils are likely to display a range of different learning needs relative to a particular topic, skill or subject. Differentiation describes a way of responding to the necessity to match the teaching to those different learning needs (For some suggestions relating to science education, see Postlethwaite, 1993). Stradley and Saunders (1993) identify three key questions for any school (or presumably any institution of education) concerned with reviewing how best to meet the learning needs of all their students.

- *Can their differences in attainment and/or learning capacity be adequately met by*

grouping pupils according to ability or past performance, whether general or subject related (through setting or banding)?

- *Will differentiation necessarily lead to teaching different curricula to different pupils, whether in groups or individually?*
- *Or can differentiation be better realized through teaching the same curriculum to al pupils but tailoring the teaching approaches and processes to the different learning needs of individual pupils?* (p129)

Answers to what we are trying to achieve in terms of pupils' understanding of the curriculum, what is possible for them to understand, and what they themselves wish to understand can only be helpful in reviewing any policy for meeting learning needs. Although writers have begun seriously to explore understanding within educational contexts, there still seems to be some room for further debate and clarification. The next chapter will attempt to contribute to the process of clarification by considering the concept of understanding within a more theoretical framework.

Chapter 3
Conceptualising Understanding

The previous chapter attempted to demonstrate a relevance of thinking about understanding within the current context of educational practice. A pressure to develop a clearer view of understanding was found to arise from the shift in educational epistemology, the changing uses of assessment and a need to throw light on the meaning of the somewhat vague allusions to the importance of understanding in the documents which govern educational practice.

This chapter will draw upon thinking and research from a broader background than education in an attempt to establish the starting point for a framework for thinking about understanding. It is hoped that this will lead to a more complete conception of understanding which can then be applied more meaningfully to educational settings, and which will facilitate a linking of findings across a range of research contexts.

Levels of explanation, biological constraints and contextual constraints.

It is now commonplace to accept, but nevertheless still worth restating, that human beings are complex biological organisms which are required to live and function in complex social systems (eg. Ashworth, 1979). We are therefore constantly faced with the difficulty of dealing with this complexity in a meaningful manner. One way of handling biological and social complexity, is to regard areas of explanation as being independent of each other. This approach has apparently been favoured by many of those who take an information processing approach to the study of cognitive psychology. Following Marr (1982), cognitive psychology has tended to adopt a model of explanation as being based on three independent levels of explanation (Trehub, 1991). These can be described as being:

1) The level of computational theory at which the computational and its logic are formulated,
2) The level of representation and algorithm at which the representations for input and output and the algorithm for transformation are formulated.
3) The level of hardware (or biological) implementation at which the physical means for realising the representations and algorithms are formulated. (Trehub, 1991, p3)

Trehub argues that, even though cognitive psychology does not dismiss brain

physiology as irrelevant, it has tended to proceed by developing theories of explanation at the levels of computation and of algorithm and only then, if at all, looked at how these might be implemented in the human brain. In Trehub's view, this leads to an over abundance of theoretical models, and misplaced empirical studies which are based upon these models (particularly at the algorithmic level), than would have been the case had a distinction been made between models which are consonant with biology and those which are not. Biological plausibility should act as a constraint on theory building. That is, assumptions that are not credible on the evidence of neurophysiology and anatomy should be pruned out. Trehub refers to this as an 'interdependent-levels search'.

As well as providing conceptual constraints, it is also seems possible that lower levels may provide clues as to a phenomenon's nature. In the case of investigating human understanding, we might ask about the clues to the nature of understanding which biological based research has to give. This seems compatible with a broader view than the above in which disciplines are conceived as having a hierarchy based upon focus of interest and in which disciplines may target a particular phenomenon from different perspectives (Bechtel and Abrahamsem 1991). Bechtel and Abrahamsen argue that 'higher level disciplines' may draw on sub - disciplines from below for explanation, constraints, and ancillary evidence.[1] However, 'traffic' occurs in the opposite direction. Bechtel and Abrahamsem see 'lower sub- disciplines' as recipients of specialised descriptions of the research domain from 'higher level disciplines'. Support for this can be obtained from Argyle's (1988) illustration of the need to draw on various levels of explanation to answer the question, "Why do people smile?" He draws upon seven levels ranging from physiology through cognition and social interaction to culture. In his descriptions of the explanations, this two - way traffic can be detected. For example, the cognition level talks about needing to learn the rules of socialisation (the level below cognition in Argyle's analysis) in order to participate in social interaction (the level above).

This analysis seems to imply that education can be regarded as being a higher level discipline providing specialised descriptions to such sub-disciplines of psychology as cognitive psychology, social psychology and so on, which may have a focus upon educational learning, which in turn would be sources of explanatory aids and constraints to educational theory. The psychology disciplines in turn would relate to

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[1] Although restricting his argument to cognitive science, Cussins (1990) also advances a view of explanation as arising through a hierarchy of mutually constraining levels of analysis. Gould (1980) seeks to use a hierarchical view of nature to present a view of evolution in which each level has a uniqueness of context for the common laws which apply to the levels.

such sub- disciplines as neuropsychology and ethology [2].

It seems that these views require a little modification when understanding is the focus. Understanding is about the interpretation (or processing - depending on our level of description) of phenomena or information in the social and physical world and, as such, the focus of interest is not only related between disciplines immediately above and below. Relationships and constraints may cross more than two levels in the explanation of understanding.

It is certainly true that in the case of understanding, biological constraints are not the only ones to be taken into account. Any description of cognitive functioning must also consider what occurs outside the brain (Russell, 1984). Therefore, a theoretical description of the phenomenon of understanding must also be plausible in terms of the constraints placed upon it by its occurrence in complex social situations. Indeed, some commentators might wish to argue that understanding is essentially a form of functioning in social settings, and that it is in these settings that explanations of variability in understanding are likely to reside.

This may be true if variability is taken to refer to the content of understanding but context is not necessarily sufficient to provide explanations of the mechanisms by which understanding develops. Buss (1991) describes a fundamental situational error which he claims arises frequently in behavioural research of a biological nature, just as often as in research into individual differences and social psychology.

The fundamental situational error is to assume that, because situational variance can "account for" behavioural variance...., a coherent explanatory account need not invoke stable psychological mechanisms....residing within the organism. Without internal mechanisms there can be no behaviour. (p 461)

In short, we look for answers as to how understanding is possible by considering the species specific biological and psychological mechanisms of human beings. We look for answers as to how particular understandings have emerged by considering the interactions of these species specific behaviours with the physical and social environment as the individual develops from birth (or before) to the time and context of study. To put it in another way, understanding is a coin with two sides. It is at one and the same time an internal phenomenon of individuals with an outside to in direction of fit (the organism can only recognise, process and comprehend what its biological apparatus allows) and a socio-historical construction with in the physical and social world which has an inside to out direction of fit (the organism can only

[2] A similar case can be made for the emerging discipline of gerontology (Rabbitt, 1988).

process and relate to what it actually encounters in its physical and social contexts). This requires us to be as clear as possible in devising descriptions of biological and psychological functioning, of context, and of how these all interact. There is a need to connect psychology to biology (Edelman, 1992) and psychological processes to context (Simon, 1990).

The contemporary view tends to be that cognition is typically situated in social and physical context and is rarely, if ever, decontextualized. (Butterworth, 1992, p1, Original emphasis.) [3]

If we focus on how understanding occurs, this requires that we have descriptions of context, and descriptions of how that context is handled by the person, which are viable at biological, psychological and social levels of explanation. If the focus is understanding in educational settings, then the description also needs to be viable and fruitful in educational terms.

What, then, are some of the demands that educational theory places upon our thinking about understanding?

Types of educational theory and the complexity of explanation in education.

Bereiter (1990b) distinguishes between two types of educational theory: explanatory theories and instructional theories. The former type of theory seeks to explain how learning actually occurs in educational settings, whereas an instructional theory aims at setting out the best ways to promote learning. In Bereiter's view, the two types of theory are not synonymous, although a good explanatory theory should be capable of providing an appropriate basis for an instructional theory. This distinction seems useful, although it may be the case that implications for instruction will flow more readily from explanatory theories than Bereiter seems to be implying.

Successful explanations make the phenomena or outcomes under consideration intelligible to ourselves and others. This is no easy task with regards to educational learning. Entwistle (1987a, 1987b, 1990, 1996) offers a heuristic model (Figure 4) of the teaching learning process by showing a range of factors (or concepts derived from research into the process) which relate to or influence it in some way. Even this

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[3] For earlier writings in this vein, see for example, Barker, 1968. and Brunswick, 1957, who have been influential in the development of ecological psychology (eg. Schlechter and Robinson, 1988)

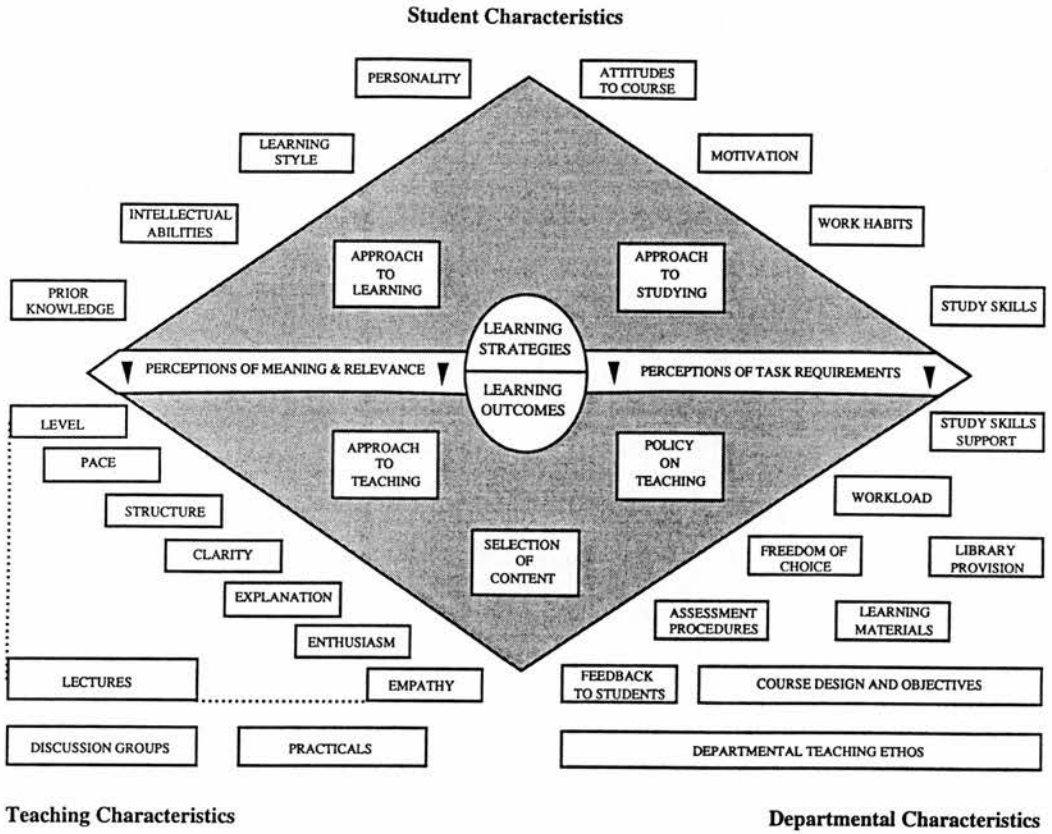

FIGURE 4: ENTWISTLE'S HEURISTIC MODEL OF LEARNING.

type of modelling strategy does not guarantee completeness since it is unable to show the interaction between the learner as a biologically developing individual (who therefore may have different physical and/or mental capabilities at different ages) and the learning context.

Another insight into the complexity of explanation in education is provided by Bronfenbrenner (1979). He offers an analysis of individual functioning as occurring within a context of nested systems (micro, meso and macro), each of which may have some relevance to the explanation of behaviour. For example, the learner in the classroom can be thought of as a microsystem nested in other systems such as the school, the education authority, the local community, the country, and which is influenced by other micro-systems such as the family and friendship groups. Bronfenbrenner (1988) has subsequently postulated a chrono-system to represent the changing nature of these systems through time. This complexity implies that the learning process will be unique for each child whatever the curriculum theory the teacher does or does not follow (Barrow, 1984).

In conceptualising understanding, one possible way of dealing with this complexity of influences in educational contexts is to treat them as having an effect upon the individual's perception or interpretation of that context. Interpretation of context has a central place in Entwistle's model. Perhaps strangely, given the possibility of using it to handle complexity, most theorists have been guilty, until recently, of overlooking the individual's perception of context as a factor, let alone a synthesising factor, in explaining how an individual responds in educational learning (White 1988). However, the role of the individual as an interpreter of context during action has strongly been emphasised in the early phenomenographic research (eg. Marton, 1981; Marton and Säljö, 1976a, 1976b.). It is also, perhaps in a different sense from phenomenography, a central tenet of constructivism that human beings construct mental models of the environment and interpret new experiences in relation to these (Driver, 1988; Duffy and Jonassen, 1991; Happs, 1985; Paris and Byrnes, 1989). Within the social context in which it is used, the term 'understand' already conveys meaning. The next step is to examine that meaning.

Understanding as Intentionality

Understanding is an intentional word (Searle, 1983). It is also at the intentional level which Bereiter (basing his argument on Dennett, 1978, 1983) believes adequate explanatory theories of educational learning must be formulated. It is at this level, he

argues, that humanistic and philosophic theories can be framed, but also at which it is possible to construct theories which are scientifically testable.

Dennett (see also 1991, 1996) describes intentional explanations as those which talk about a system in terms that imply it has beliefs and desires. The system is imputed an agenthood which may be pseudo or genuine. Taking an intentional stance means that we treat the entity we are studying as an agent which will behave in a way which is rational according to its own perspective. We assume that it makes only the smart moves (given its limited perspective).

We describe that limited perspective by attributing particular beliefs and desires to the agent on the basis of its perception of the situation and its goals or needs. (Dennett, 1996, p34. Original emphasis)

Beliefs and desires are Intentional States.[4] Intentional States have a sense of being about something (Bechtel, 1988). There is a logical or real connection between the Intentional State a person has, or is in, and events, states of affairs or objects in the world. What Intentional States refer to are called Intentional Objects. One cannot use Intentional terms without specifying this connection. A person has a belief that X is the case; a fear of Y; or understands A but not B.

This is generally the starting point for philosophers when discussing Intentionality (Searle 1983) but, true to their tradition, they build different perspectives upon it. For example, Searle (1983, 1984) takes a view that Intentional States are very real in the biological sense - as real as digestion or blood circulation. Dennett on the other hand, takes a more instrumentalist position - at least in his earlier works. His interest in Intentional States derives from originally perceiving them as a conceptual necessity (Bechtel, 1988).

Bechtel's own view is interesting. He outlines what he refers to as a form of 'teleological functionalism'. This begins by treating mental states as adaptive features of organisms and interpreting them in terms of factors of the environment with which the organism has to cope in order to survive (See also, Millikan, 1984). That is, he attempts to place Intentional States in an evolutionary framework. There are internal processes which have evolved in the organism allowing it to have Intentional States. Different organisms can be studied in order to examine how they have evolved to

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[4] The convention adopted to in Chapter 1 will now again be adhered in which 'Intentional states' and 'Intentionality' are spelt with upper case I to distinguish the terms from 'intention' which is just one Intentional State or form of Intentionality.

relate cognitively to their environments. However, he is careful to avoid arguing that the mental states and their functions for the organism are themselves the products of selection.

Rather than requiring that functions be adaptations (i.e. the product of selection), we need only require that they be adaptive (i.e. they increase the likelihood that the organism will reproduce). (This distinction is due to Brandon, 1981.) That is, in ascertaining what the function of something is, we should look at how the trait will benefit the current organism in its quest for survival rather than how it aided its ancestors. (Bechtel, 1988, p 137)

The cost for this position is that, since we are not explaining the origin of a trait in ascribing a function to it, we are not indulging in functional explanations but only in functional analysis. Nor does this position commit one to sociobiology. Cognitive strategies can be thought of as evolving to meet evolutionary needs without them being reduced to genetically coded adaptations. Teleological functionalism offers

the prospect of a rapprochement between the internal processing focus of cognitivism and the environmental focus of behaviourism. (p.140)

This statement is compatible with the position reached above in which a distinction was made between the biological and psychological mechanisms for understanding, and the understandings developed in particular contexts. It can also accommodate the observation that individual perception and interpretation of context is an important focus of interaction between the internal mechanisms and the external context. As such, teleological functionalism seems a useful stance to adopt. It is also in line with an approach taken by Donald (1991) in developing a theory of the evolution of the modern mind as involving types of culture which can be supported by forms of representation. According to Donald, modern Man is unique, both in the present and in evolutionary history, by having a theoretic culture made possible by the type of abstract concepts available, not only through language but also other forms of representation, and by the fact that much representation can be external to the individual. However, cultures vary in the use made of the available types of representations - both in the extent to which they are used (not all cultures are literate) and in the detail of the representations (different cultures have different representations). The form and types of representations used in a culture will therefore affect individual cognition. Dennett (1996) also emphasises the unique role of external representations in modern cognition. Cognitive tasks are 'off-loaded' into the environment by using these external representations.

The only trouble with the evolutionary approach is that Homo sapiens now seems to be evolving in a different way from other species ... The existence of civilisation rests

crucially upon our ability to record our thoughts in writing and, more in other media as well. ... It seems that we are on our own now; having taken over from nature, we must accept the responsibility for our biological future. (Longuet-Higgins, 1973, page 7)

In summary, the argument to this point is that an educational theory of understanding should be firstly an explanatory theory, and an instructional theory only by derivation. It, perhaps can be best formulated at the Intentional Level and in line with teleological functionalism. It can usefully place interpretation of context by the individual in a central role, and it is argued that the way in which this is seen as occurring should be compatible with biological and psychological evidence and thought. This seems most likely to be achieved by drawing upon constructivist and phenomenographic theory and insight. It also seems possible to endeavour to show that the perceptions of context, and their influence upon understandings as Intentional States, are adaptive in some way to individuals in the culture to which they belong, and that they are in line with the forms of representation they have available, or are using. If so, this would enable us to place explanations of educational outcomes, or failure to reach them, in a broader context of social and cultural explanations.

As will be clear later, this last criterion requires the realisation that, in a narrowly focussed study, Intentional States may seem maladaptive from the experimenter's point of view, yet still maybe adaptive to some needs of the individual which derive or relate to situations outwith the scope of the study. In taking account of a broader context of interactions between individual and social/physical environments, our interpretations as researchers may thus need to be revised. Of course, that would leave us with a practical problem of how wide to cast our nets when researching any Intentional State such as understanding. Any theory of understanding should therefore help us to deal with this difficulty.

The next section will attempt to approach this problem by, first, considering further the nature of human adaptation. From this, the next chapter will begin to map out a conceptual framework, intended to provide a structure within which theories of understanding could be developed and tested in line with the above criteria. Central to this framework will be the earlier point that individual perception and interpretation of context is an important link between the internal mechanisms and the external context. It provides an avenue through which the complexity of context can begin to be handled as to how it impinges upon a narrower focus of study, in both a historical sense (in the development of the individual) and in an ecological sense (as the individual moves from one context to another).

Understanding as adaptation

It was suggested in the previous section, that we can follow teleological functionalism and treat mental states as being adaptive. Mental states can be interpreted in terms of the environment with which the individual has to cope in order to survive. However, from what follows, it will be clear that adaptation is not always a concept which as simple to apply as it first appears.

Adaptation is a term which has had some lack of clarity in much of the literature - even that of evolutionary biology (Good, 1981; Lewontin, 1978). Despite this, it is a central concept in the literatures of both the biological and social sciences. For example, from a constructivist perspective, adaptation by individuals to their circumstances is seen to occur through the interpretation of those circumstances by the construction of mental models. From this perspective, von Glaserfield (1989) sees adaptation as an individual managing environmental constraints. Organisms

must be able to manage their living within the constraints of the world in which they live. (p10)

Adaptation is a concept which von Glaserfield believes applies to cognition as well as in the context of biology and evolution, but with one important difference.

The cognitive organism tries to make sense of experience in order to better avoid clashing with the world's constraints. It can actively modify ways and means to achieve greater viability. (p10)

We will see that this definition is fine as far as it goes, but that it is also something of an oversimplification. One area of research literature which has been particularly concerned with concepts of adaptation comes from the interface between biology and anthropology where study is focused upon the development of culture.

Dyson-Hudson (1983) notes that the use of a common word, such as adaptation, can lead us to believe that biologists and social scientists are trying to explain or analyse the same phenomenon. He also notes, that despite some difficulties, biologists have a greater consensus about the meaning of adaptation, and this incorporates the following features.

- Adaptation occurs through natural selection in all its aspects - morphological, physiological and behavioural.
- Adaptation generally refers to any feature of the organism which contributes to its

survival and reproduction.

- There is no end to adaptation since the environment is not constant, but is constantly changing.
- Following from this, adaptation does not involve organisms in becoming better and better adjusted to a fixed environment. Rather, it is a series of adjustments according to the environmental conditions at a given time.
- Evolution by natural selection does not involve a preordained plan and so adaptations are not preordained either.
- Natural selection generally operates at lower rather than higher levels of organisation. That is, it operates at the level of the individual or perhaps at the level of gene complexes. It does not operate at the levels of groups, populations or cultures.

Dyson-Hudson does not find a comparable consensus in anthropology. However, in line with the levels of analysis approach taken in this thesis, it is necessary to look for the constraints which operate between these disciplines for implications for the study of understanding.

According to Dyson-Hudson, anthropological definitions of adaptation range through those involving physiological and morphological adjustments; those in terms of change from egalitarian to complex, hierarchical societies; and, finally, definitions involving behavioural adjustments. Therefore, it would appear that anthropological definitions of adaptation can refer to adaptations of the individual or to adaptations of culture - or aspects of it. For the present purposes of applying a levels of analysis approach to thinking about understanding, a meaning of adaptation is required which allows a combination of both individual and cultural types of definition. Dyson-Hudson cites a behavioural description from Bennett (1976) which seems to offer the possibility of some progress in this direction. Bennett defines adaptation as:

the coping mechanisms that humans display in obtaining their wants or adjusting their lives to the surrounding milieu, or to the milieu of their lives and purposes. (p246, emphasis added)

This definition is useful on several counts. Firstly, it allows us to include society as part of the environment with which individuals cope (Dyson-Hudson, 1983). Secondly, it seems to be compatible with teleological functionalism since it includes 'wants', and 'purposes' as components with which the adaptive mechanisms are coping. These terms are Intentional. Thirdly, it opens up the possibility of seeing

human adaptation as occurring horizontally and vertically across the contexts of a life milieu. It will be suggested that understanding does not only involve relationships (or adaptations) to the immediate setting, but also deals with the 'wants' of the person and the 'milieu' of the individual's life and purposes in ways which do not always correspond. Fourthly, it allows us to consider individuals as themselves changing in a world which is also changing. This, argues Riegel (1976), is the main theme of developmental psychology as well as dialectical psychology (see also Bronfenbrenner, 1977, 1979).

Further support for this view of adaptation, and its implied utility for considering understanding to be an adaptive relationship, is offered by Little (1983). He distinguishes between an evolutionary way of looking at adaptation and a secular or temporal view. The latter view places less emphasis on genetic systems and more on the survival and general well-being of the organism and the population. In a way which seems in line with Bennett's definition, the concern of the temporal view is with individual coping, behavioural and biological adjustments to stress, the relative merits of different individual and population strategies, physiological flexibility and, perhaps, genetic plasticity [5] (see also Rappaport, 1979; White, 1976). In general, all these authors view adaptation as occurring across a hierarchy of levels [6].

It is also the case that, relative to particular contexts, adaptations at different levels may be at odds with each other. For example, Boyden (1992) describes how diet can undergo cultural adaptations to technological and economic forces with people eating more refined food with less roughage and more sugar. However, at another level this is not adaptive, as it leads to more bowel cancer and dental caries. Still, it is possible for individuals or cultures to become aware of such adaptational conflicts (perhaps, we might say that this is through adaptations at an analytical level) and to take remedial action of two types (Rappaport, 1979). In corrective adaptations, there is an attempt to remove the cause of the disharmony. In antidotal adaptations, there is an attempt to alleviate the symptoms of the disharmony, rather than removing the cause.

Granott and Gardner (1994) also note the possibility of conflicting adaptations. Following Bronfenbrenner (1979), they view the individual's total environment as

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[5] Little does not elaborate on the possible inclusion of genetic plasticity, but it is consistent with the later arguments in this thesis, to consider genetic plasticity as an underpinning for the developmental plasticity which gives personal understanding its individual uniqueness.

[6] For a view of behavioural adaptation which involves layered but not hierarchical levels of subsystems, see Thelen (1993).

consisting of various settings which are nested. However, each environmental setting (eg. home, school) comprises three different kinds of environment: a physical environment, a social environment and a symbolic environment. These three different kinds of environment are not necessarily consistent across settings. The symbolic environment of the school may differ from that of the home.

What emerges from this discussion is that human adaptation requires a reference to a particular context - and perhaps different aspects of that context. Furthermore, we must try to be clear about how that context fits in with the levels and range of contexts which exist in an individual's life milieu. If understanding is to be seen as being an adaptational state, a framework for understanding understanding must be consistent with the complexity of adaptation. Figure 5 tries to show something of the flavour of this complexity of adaptational relationships between a person and various contexts within a life milieu. Evidently, there can not be too much disharmony between adaptations, or a person would cease to be able to move easily from context to context within a life milieu.

Figure 6 may be nearer the mark by showing adaptation as a mixture of integrated and unintegrated adaptations. However, it is not so easy to specify where any general consistency, which allows cross functioning in contexts, will be found. Rappaport (1979) suggests that there is a hierarchy of values associated with adaptation. In well ordered adaptive systems, low level values are highly specific and instrumental. On the other hand, higher order or ultimate values are vague - what is 'happiness', for example? We may place the ultimate adaptational value in the general wellbeing or health of the individual across levels and contexts. Holistic definitions of health take this approach and see health as a concept which covers physiological, psychological and social levels of analysis (see Lazarus, 1991 for a review of the concept of health).

Lazarus notes the attractiveness of holistic definitions of health but also notes that they tend to be circular, as

healthy people feel good and have a positive sense of themselves and the world because they have a positive sense of themselves and the world and feel good. (p. 390)

Some might suggest similar definitions of adaptation and understanding.

Well adapted people cope well across and through the levels of their whole life milieu because they cope well across and through the levels of their whole life milieu. and

FIGURE 5 ADAPTATIONS OF PERSON TO CONTEXTS ENCOUNTERED IN LIFE MILIEU

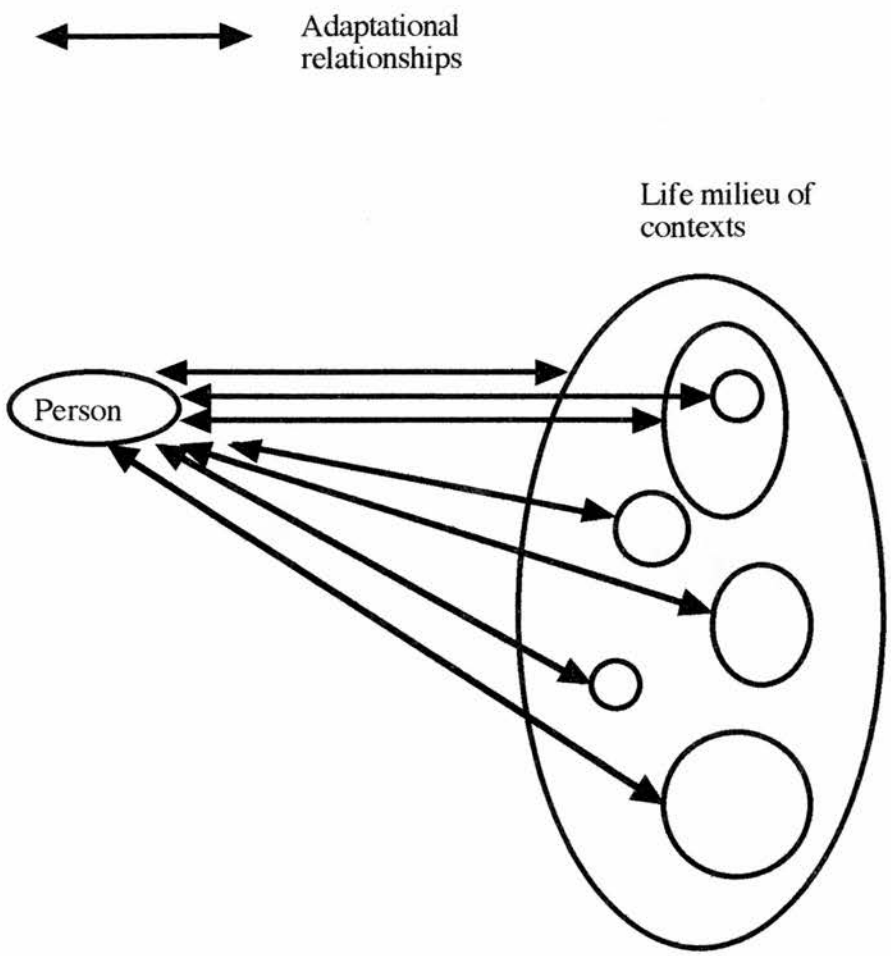
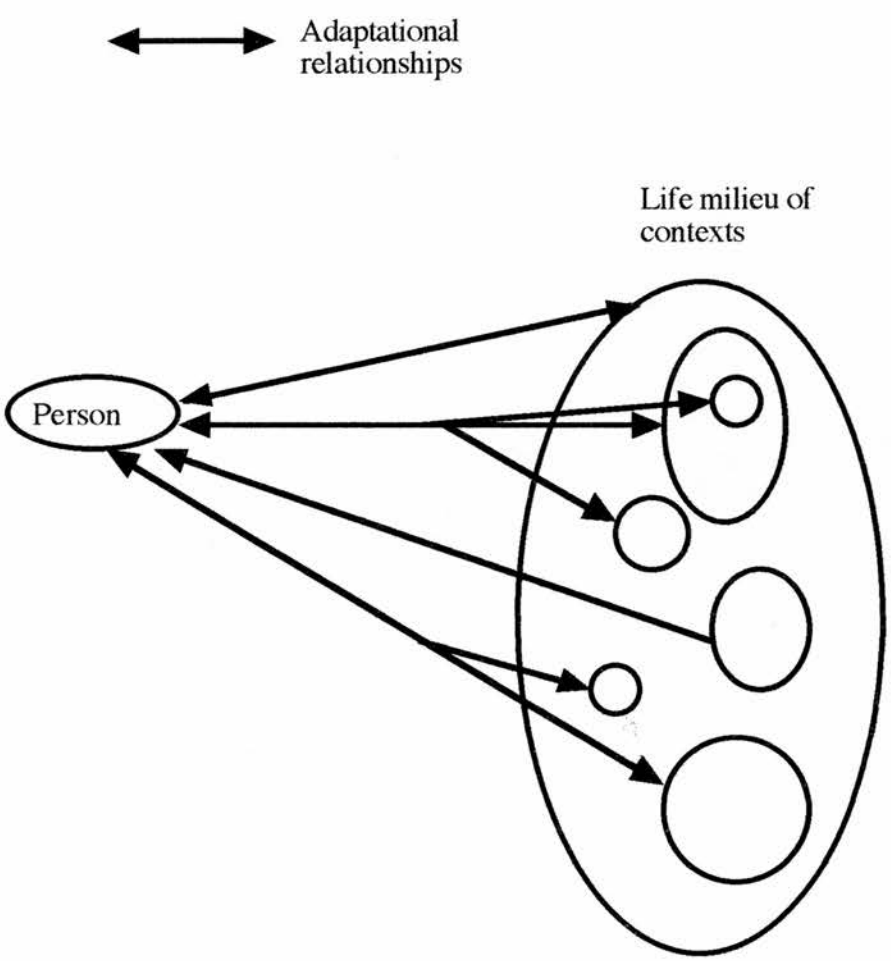


FIGURE 6 INTEGRATED AND UNINTEGRATED ADAPTATIONS OF PERSON TO CONTEXTS ENCOUNTERED IN LIFE MILIEU.



Understanding copes coherently across and through the levels of context because it has coherence across and through the levels of context..

Lazarus suggests that some circularity in definitions of health is probably inevitable, but efforts must be made to unpack our concepts to aid explanation. In the cases of adaptation and understanding, however, there is perhaps a different solution. The above statements are not really definitions of adaptation and understanding. Rather, they are descriptions of the recursive and iterative relationships within them. They reflect the way in which later states take earlier states into account, or the ways in which later states depend, in part, on earlier states.

The above also suggests that, at present, our language of explanation is struggling to meet the problems of description in these contexts - a point to which we shall return, But this issue of how understanding and adaptation exist through time (not just at a time) is important. An explanatory theory of understanding has to attempt to deal with problems of description, before it can become more predictive. Russell (1984) describes how psychologists have to start with a working model of psychological subjects of study, such as belief, before beginning an investigation. In education, it is perhaps the case that we have not got as far as an adequate working model of understanding, at least in our explanatory theories, and one reason is the need to develop our descriptive language further.

So far we have demonstrated that human adaptation is a complex phenomenon occurring over the range of contexts in a life milieu. These contexts are possibly arranged in a hierarchy, but, if not, they certainly seem to be layered upon each other. Adaptations to different contexts in a life milieu are not necessarily compatible, nor do they necessarily involve the same means of adaptation. Perhaps, we should use the the following quote as a cautionary reminder by applying it to contexts within cultures as well as between them?

There are few dumb children in the world if one classifies them from the perspective of the community of adaptation, but millions of dumb children if one classifies them from the perspective of another society (Kagan and Klein, 1973, p. 961).

If understanding is to be viewed as a form of human adaptation, it must incorporate, or be compatible with, these observations regarding the complex relationships between individuals and contexts, along with the need to consider what perspective (subject or observer) is being applied. The next chapter will attempt to pick up the implications of them, as it moves towards a framework for thinking about

understanding. This framework will attempt to move forward the ability of educational theory to explain understanding. This would open up the possibility of more predictive explanations which could be applied and tested against data from the application of instructional theories.

Chapter 4
Towards a framework for thinking about understanding

In Chapter 2, it was noted that it is possible to think of educational practice moving from a basis in an epistemology of intelligence to an epistemology of mind. This shift in epistemology is seen to give a relevance to the concept of understanding by bringing out its problematic nature. In Chapter 3, some theoretical parameters were set out within which explanations of understanding can be worked out. If one aim of this thesis is to be satisfied, that of relating theory to practice, some further exploration of the possible relationship is required. This chapter aims to move towards a model which can be used, as an initial basis, for exploring the possible types of relationship between instructional theory and practice, while still offering some link to explanatory theory. Drawing on theorising within psychology, this model will bring together educational epistemologies and the possible outcomes for the students of their application. The concept of forms of understanding (Entwistle and Entwistle, 1991a, 1991b) will be used as a provisional description of outcomes for the student. The concept of educational epistemologies will be opened out slightly to suggest a middle position between an epistemology of intelligence and an epistemology of mind. The psychological background, on the other hand, will be only loosely described as a movement towards what can be called theories of personal meaning, as represented by forms of constructivist theories. Some types of psychological theory seem more supportive of the concept of understanding, which begins to emerge as being applicable at the educational level of explanation. However, a detailed analysis of alternatives is beyond the scope of this discussion. The model will then be used later as a link between educational practice and a theoretical analysis of understanding in a more explanatory sense.

The initial question in formulating the model is to ask how psychology relates to the epistemologies of intelligence and mind. It is also necessary to ask how understanding can be viewed as being an adaptation. Within a broadly psychological framework we can include more biologically orientated perspectives on development and mental functioning. This can be justified in terms of the earlier stated criterion that theorising about understanding at the educational level should be compatible with biological levels of theory. Therefore, we will begin by looking at understanding from this perspective.

Some contributions from biologically orientated research

Two trends in this area seem relevant to present purposes. Firstly, there is an emphasis upon the possibility of a degree of plasticity in both development and in behaviour (Aoki and Siekevitz, 1988; Edelman 1989,1992; Fischbach, 1992; Gollin, 1981; Greenough et al, 1993; Lerner, 1984; Lynch, 1979; Kolb, 1993; Patterson 1979). Although plasticity is not necessarily unlimited - Lerner (1984) uses the term 'relative plasticity' - it is now seen as central to the way in which the brain supports mental life.

Plasticity weaves the tapestry on which the continuity of mental life depends (Fischbach, 1992 p. 30).

Although authors emphasise different aspects of plasticity, they seem to share a common ground in emphasising a role for context in brain development. Furthermore, context is seen as being relevant at all levels of analysis. For example, if the focus is upon the growth and interconnections which an individual nerve cell makes, then the context of this can be thought of as the other neuronal cells within the same part of the brain. If the focus is on the development in functioning of groups of nerve cells, the context may be features of the external environment, such as light patterns.

Lerner (1984) argues that a context is a system which constrains, and that it is this constraining function of the context which defines the meaning and functional significance of plasticity. Mechanisms which give rise to plasticity are the same ones that provide for human commonality and consistencies. For example, at one level, genes may give rise to neuronal growth, but do not specify exactly the patterns within which that growth will occur. Genes are one of the constraining influences together with chemical events involving substances which influence cell adhesion or substrate adhesion. The resulting connections of neurons into groups in turn become a constraining factor (Edelman, 1989; Johnson, 1993), along with the organism's behaviour in determining future connections of neurons (Edelman, 1989).

Lerner also gives a clear and useful indication of how plasticity in biological development can be seen to underpin flexibility in behaviour. Flexibility is seen as a sub-concept of plasticity which refers to the behavioural aspects of plasticity.

Let us use the term plasticity to refer to the evolutionary and ontogenetic processes by which one develops one's capacity to modify one's behaviour to adjust to, or fit, the demands of a particular context. These plastic processes may then be said to contribute to the development of what we will term flexibility. Thus, plastic developmental

processes (both at a given moment and across time, and both within the organism and between its context) produce behavioural organisation that is flexible, that has the capability of changing appropriately to meet contextual requirements. (Lerner 1984 p 10)

This type of perspective upon development tends to place an emphasis on individuals adapting to their unique contexts (Lerner, 1984; Sroufe, 1979), and suggests that each of us will have the architecture of our brains modified in slightly different ways as we encounter different combinations of stimuli and exercise sensory and motor skills in various guises (Kandel and Hawkins, 1992). This seems compatible with the view of human adaptation we arrived at in the previous section.

A second, and not unrelated, theme is to view the brain as a constructor of representations - not just a recorder of sensations (Goldman -Rakic, 1992; LeDoux, 1985; Oatley, 1985). Furthermore, the functioning brain is seen as having aims and objectives so that its set of representations are of things wanted, hoped for, and so on. Representations allow the expectation of actions or outcomes with reference to some state of affairs not already present (Young, 1986). Organisms are 'anticipatory' (Rosen 1985) - that is, behaviour is driven by expected consequences, not simply as direct reactions to the immediate present. Or, to put it another way:

Organisms can bring the future into the present, as it were, through a combination of current peripheral discriminations, central planning and motor actions. (Notterman, 1985, p. 49)

Anticipatory behaviour is possible because the world is represented in terms of models which allow predictions to be made (Jacob, 1982; Rosen, 1985). These representations - although they are based on a physical world which seems to be real - are themselves personal, or ultimately subjective.

Jerison (1985) argues that different species have different experiences of realities since their sensory and central nervous systems process information from the external world in different ways. This also applies within species. For example, a colour - blind person's reality will differ from a trichromat's. However, external reality is seen as constraining experienced realities as are similarities in functioning of the nervous systems (of vertebrates at least). In consequence, according to Jerison, the constructed realities will retain appropriate isomorphisms with physical reality. Constructed realities of different species are described as being analogous to translations of the same ideas into different languages. In the human case some authors are quite clear

that subjective experience of reality is the reality to be studied.

The reality we experience is a personal one, a subjective construction of the conscious self and its arsenal of verbal skills. Each individual, on the basis of his past experiences, present situation and future plans, and through the use of natural language and its flexibility in analysing and codifying experiences and interrelating experiences systematically, constructs a systematic view of the world and his place in it. (LeDoux, 1985, p. 210)

Donald (1991) develops a relatively strong position on the relationship between plasticity and representation in the tertiary (association) cortex. These areas receive information which has been previously processed by other regions at various parts of the brain but apparently they lack any single and permanent genetically determined input. Therefore, in theory at least, they are capable of attaining a wide variety of wiring schemes depending upon the patterns of early experience and consequently there is the possibility of considerable individual variability in the functional organisation of the adult neocortex. Donald expresses this as the *principle of singularity* whereby the individual human brain is said to develop a unique functional organisation at the representational level. In short, we have evolved a biological capacity to be sensitive to, and to be able to adapt to, a wide range of cultural requirements.

Drawing these themes together, we can see that this type of theorising, while maintaining a concern with species-specific characteristics and a consistency or continuity of the individual, seeks to allow for individual 'adaptivity' to context which occurs through a personal construction of reality, and of how that person relates to it. Presumably, like species adaptivity, this individual adaptation to context can be less than ideal while still ensuring some degree of success. Adaptation does not necessarily imply a perfect fit with context. Observers may discern better methods of adaptation or describe a degree of adaptation which no individual (or species) has actually attained. Also, individuals may exhibit a range of variations between each other while still remaining adapted to the context - in so far as they cope with that context. Adaptation is not all or nothing, but, instead, there are degrees of adaptation and variations in adaptation.

There is an additional feature of certain types of adaptation. Adaptation of individuals - human individuals, at least - includes a representation of the future, which includes predictions about it. Individuals have goals which arise from their representation of the past and the present, and of their predictions for the future, which they use to direct their actions towards these goals. What they do depends on how they interpret the situation, their capabilities, and the likely outcomes of how they interact with that

situation. Individual adaptation depends upon these predictive abilities - that is, it is dependent upon anticipations by individuals leading to the attainment of goals which are relevant from their own point of view. This adds to the discussion of adaptation and Intentionality above by adding an anticipatory component to adaptation. Most specifically, adaptation occurs through the interpretations the individual makes, based on the way the contexts have been represented. In this sense, understanding and adaptation go together.

We can see how the milieu formed by these directions in theory is also supportive of an interest in understanding both as a phenomenon and as a technical concept. It may be an exaggeration to claim that this milieu is a cause of an interest in understanding, not only in education, but also in other disciplines. Things are likely to be far more complex. All such thinking is possibly part of a larger, more encompassing, milieu.[1] Suffice it to say that thought in biologically based psychology not only does not gainsay the study of understanding, but instead it appears actively to encourage it. The following quote may help to put this in an educational context.

The brain does not usually learn in the sense of accepting and recording information from teachers. The brain is not a passive consumer of information. Instead it actively constructs its own interpretations of information and draws inferences from it. The brain ignores some information and selectively attends to other information. (Wittrock, 1978, p. 101)

In fact, the above considerations can be paraphrased in terms of understanding. Action in a context depends upon individual understanding of that context, and that understanding has an anticipatory component. Mastery of academic content would be no exception to this. The action of learning curriculum material occurs in a context, and the material to be learnt or understood is itself a part of that context. The action of incorporating the curriculum material into our understanding of the world and ourselves - the way our brain incorporates it into our representations - is a function of our interpretations of both the curricular material itself and of the context in which it is presented, along with our own anticipations of the outcomes of particular ways of attempting to incorporate it. The implication is that, as teachers, we cannot expect to 'build a particular understanding' in the heads of our pupils as an automatic consequence of feeding them information. Instead, our students will develop their own understanding, which may or may not match what we are aiming for, but which will depend upon their individual history, their interpretation of the present, their

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[1] Perhaps, a general move to Constructivism across all disciplines. Something we might expect to happen from the Bechtel and Abrahamsen (1991) conception of mutually constraining disciplines discussed earlier.

goals, and how they anticipate their future.

This type of thinking - or at least features of it - is already fairly common in educational literature and rhetoric, but the fruits of it may not always be apparent in practice. This may be because many educators - including those in authority - may not really be interested in theory or in being rigorous enough in considering its implications. The problem is as Barrow (1984) points out that one cannot separate practice from theory. Practice - even the successful practice of those who claim to have no interest in theory or who have little understanding of it - is grounded in theory. It is possible to give examples of successful action on the parts of individuals who have little theoretical understanding of why they are successful, but

no amount of multiplying such examples of the divorce between acting and understanding will alter the fact that good practice logically presupposes theory, as a good bridge presupposes scientific theory and a good painting theory of art, in the sense that the goodness in question is a matter of the bridge or painting matching up to theoretical requirements.

Recognising that one's teaching, bridge-building or painting is good even more obviously requires theoretical understanding, for it is the theory that provides the standards by which quality is judged. (Barrow, 1984, p. 13)

Opposition to theory usually means opposition to other people's theories and oblivion to one's own (Smith, 1992). Similar arguments about the mistaken separation of theory and practice in the minds of educationists and the role of the former in evaluation of the latter are offered by Harlen (1993). A distrust of theory may arise for teachers if it is sometimes difficult to see how to relate a theory to practice in a complex activity such as education, and when one is continually racing to meet existing demands. The models we are working towards must do justice to the complexity of human understanding but they also need to point the way to linking theory and practice more effectively.

Some other psychological background.

One does not need to read far in psychological literature to find that it is not only in the more biologically centred studies that people are generally seen as model builders or theory makers, and it has already been noted that this is fundamental to a constructivist position. In fact, Norman (1983) takes as obvious that peoples' views of the world, of themselves, of their own capabilities, and of the tasks that they are asked to perform or topics that they are asked to learn, all depend upon the conceptualisations that they bring to the context. During interactions with people or other entities, people

form internal mental models of themselves and of the thing with which they are interacting, and it is these mental models which provide predictive and explanatory power for understanding the interaction.

As with the discussions of plasticity and representation in the previous section, the ability to form models (or theories about the world) is not generally regarded as being exercised in a totally arbitrary manner. Constraints are imposed by both the physical and the social worlds. Indeed, one debate is concerned with how to formulate the relationship between the individual and society (Gellatly and Rogers, 1989). Underpinning questions about the nature of human understanding are issues concerning to what degree individuals are given from birth, or to what degree they come into being through social relationships? (See, also, Bruner 1990). However, the above discussion, by focussing on factors as being constraints rather than cause, takes us away from 'either/or' arguments towards theoretical positions which attempt to incorporate all relevant factors in explanation. Indeed, constraints at one level may be a factor in inducing action at another.

For example, one line of argument is to suggest that mental models or theories about the world come more into their own at the limits of sense data. Sense data fail to, or are incapable of, providing an adequate picture of the world, so we theorise about it and construct models of it (Grace, 1987). Also along these lines, Neisser (1987) argues that perceiving and thinking, although very different, have one activity in common - that of placing objects into categories. Some of these categories are more natural and basic than others. Basic categories are formed in terms of intrinsic characteristics or the similarity of interactions with them. Neisser focuses on two of the less basic kinds - those which are defined by culturally given models and those defined by scientific theories. With regard to the former, he argues that categories such as furniture, tool, or bachelor, do not depend solely on the intrinsic characteristics of the objects, but on a range of cultural assumptions about them which he refers to as *'idealised cognitive models'*. For example, the concept of furniture carries with it assumptions that people live in houses or apartments which contain a range of substantial but portable objects: the category is less useful for people who live nomadically on the backs of camels.

Scientific concepts are also theory dependent. Scientific theory however, is seen as having less freedom since they have to be consistent with a wider range of systematic observations than theories based upon the concepts of 'folk culture'. However, both types of theory have their uses and are correct within their own parameters.

People who point to Mars and say "look at that reddish star" would be wrong if they

were trying to use the categories of astronomy, but they are right with respect to the folk concept of star. Both concepts are based on cognitive models, both models are consistent with a subset of objective facts, and both have their uses. (Neisser, 1987, p. 21)

The point is that these idealised cognitive models (or theories about the world) (McCauley, 1987; Medin and Wattenmaker, 1987) are said to come into their particular forms through living in different cultures or working with particular problems and social groups. The implication is that they may be highly similar in terms of structures or functions, or they may be different depending upon their target aspects of the world and their levels of explanation (Hatano, 1990). Each person brings a unique set of internal cognitive properties to his or her relationship with the environment, one source of which is the cultural factors they encounter along the way (Shlechter and Robinson, 1988). That this thinking parallells that on plasticity and representation discussed earlier seems evident. In terms of understanding, the great variety of individual differences in underlying conceptual structures may mean that understanding of a concept - even a simple one - may be quite different for different individuals (Ford, 1980b).

There are other authors who, in some form or other, talk of organisms as holding models, theories or representations of the world (Ausubel, 1968; Bruner, 1990; Kelly, 1955; Piaget, 1971, are four prominent theorists of this type). Also, a whole field of research in psychology is involved in attempting to formulate descriptions of mental models or representations in ways which rely largely upon metaphors drawn from computers. Schemata (eg Rummelhart, 1980) and scripts (Shank and Abelson, 1977) could be described as being models of models.

However, there is a lot of debate about how these models or representations of the world come about in the lives of individuals and as to whether the theoreticians' models of them are adequate. (See Bechtel, 1988; Jonassen, 1993; Russell, 1984, for discussions of some of the issues). However, the discussions of plasticity, representation and model-making in the above sections lead back to what remains as being essentially a constructivist position. Structuralist and functionalist considerations can still have a part to play in elucidating the constraints that may impinge upon the 'active, constructing organism'. Simon (1990) gives us a functional perspective in a discussion of possible invariants within human behaviour:

The problem in identifying invariants is complicated by the fact that people are adaptive systems whose behaviour is highly flexible. The invariants must be sought in the mechanisms which allow them to solve problems and learn: the mechanisms of intelligence. (p. 17)

As well as underlying mechanisms, there may also be a deep structure that helps in accounting for the complex and variegated surface structure evident as humans deploy cognitive, motivational, emotional and behavioural strategies to accomplish particular goals associated historically with adaptation (Buss, 1991). But, in the end, this conclusion still can imply that individuals are seen as progressively building up and restructuring their models of the world through their own mental activity, experience with the world, and social interactions, and that is a constructivist perspective (Armon-Jones, 1986; Driver, 1989). This returns us to an earlier point. We agree with von Glaserfield (1989) that adaptation is a valid concept for a constructivist position, but that adaptation is a more complex concept than was originally implied.

The important epistemological assumption of constructivism is that meaning is a function of how the individual creates meaning from his/her experiences. We all conceive of the external reality somewhat differently, based upon our unique set of experiences with the world and our beliefs about them. (Jonassen, 1993, p. 12)

Constructivism is distinguished from cognitive psychology by the types of mental models involved. In mainstream cognitive psychology, mental models are mirrors of reality and the individual adapts to these (Jonassen, 1993). In constructivism, at least the less radical forms, individuals adapt to reality through the interpretations they construct of it. There may be clashing, or inconsistent, interpretations across contexts, but these different interpretations still may serve an adaptive role in that context.

The following quote may help to place this possibility in educational terms, and further suggest how the milieu formed by this type of thinking, also leads to understanding becoming an issue.

Within any topic area students might display a range of understandings which are the consequences of their adroit personal interpretations of phenomena. Constructivism would say that this is a fundamental feature of the act of human learning, a consequence of individual development within a complex social and linguistic context, and one that cannot be eradicated. (Watts 1991)

There is still another psychological aspect to be included. It was noted earlier that adaptation of individual persons includes an aspect of representation of the future, which allows action in a context to be directed towards goals based upon how the person interprets themselves and the situation they are in. A constructivist psychology is only complete if it also includes this anticipatory component. A psychology of this type could be dubbed a *psychology of personal meaning.* Adaptation occurs through constructing personal meaning, and personal meaning is based, in part at least, upon goals and anticipations directed into the future.

A psychology of personal meaning would allow for individual uniqueness in thought and action, and would feature goal direction as intrinsic to the individual. A metaphor of adaptation or 'goodness of fit' can be applied to it, but the selective pressures are not ones of simple survival. They also include control over one's context and perceptions of what type of control is possible. It is the concept of adaptation of individuals to their situation which makes personal meaning accessible to study. The understandings which individuals develop can be described in terms of how they serve those individuals relative to their culture, their life history and goals, and this allows us to access personal meaning from the outside. The model we are working towards will make an an attempt to contrast a psychology of personal meaning with other psychologies in terms of the educational epistemologies which they support.

The inspiration for use of the term, 'a psychology of personal meaning', comes from Bruner (1974). The psychology he describes and develops further (eg. Bruner 1986, 1990) seems to introduce an idea of a psychology of personal meaning. In fact, Bruner uses the term, "meaning-making" himself (1990). Although aspects of Bruner's theorising are criticised (see for example, Olson 1992), it does seem clear that psychologies of personal meaning are possible, within a debate regarding how personal meaning develops, and the degree to which various constraints - biological, cultural, biographical - operate in its development. What seems useful for present purposes is that a psychology of personal meaning, is supportive of the application of an epistemology of mind in education.

Another term, although not its exact use, can be borrowed from Bruner (1974) - 'psychology of learning' This can be used here in a rough 'cartoon' fashion to characterise theoretical positions contrasting with psychologies of personal meaning. It is, however, important to note that the positions represented in this fashion are sketches, and are not likely to be found in such a simplistic form amongst psychological writing.

Within an epistemology of intelligence, it is possible to argue that, since understanding is seen as developing through a linear sequence of acquisitions, educational potential in school depends to a great degree on what occurs in the earliest years of life. Intellectual ability is fixed, either by inheritance or early experience, before school age. Education cannot alter this preset level of ability. A psychology of learning would be any psychological theory that subscribed to this position. This type of characterisation of a psychology of learning seems to have features in common with the epistemology of intelligence as described in Chapter 2 - in particular, the immutable nature of intelligence, and the purpose of education to prepare people for

their inevitable lot in life. However, theories which emphasise inheritance or early experience seem more likely to make allowance than the above sketch implies for a degree of development in educational potential after conception, or after the early years of life.

In summary, an attempt has been made to clarify some features in a psychological theory which would support the application of each type of epistemology in education, and it is suggested that the epistemology of mind fits with those features of psychology characterised as a psychology of personal meaning. A psychology of personal meaning is also argued to be the best type to handle the complex nature of human adaptation. This type of psychology, and its compatibility with adaptation, also draws one's attention more to the problematical nature of understanding, and can be recognised in constructivist theories found at neuropsychological and cognitive levels of research. In contrast, psychological theories which are closer to the category of psychologies of learning correspond more closely to, and lend more support to, the application of an epistemology of intelligence. Thus, the epistemology concept can serve as a useful link between psychological theory and educational policy and practice. One way psychological theory can put constraints on curriculum theory and practice is through the educational epistemology it encourages.

Before showing this linking in diagrammatic form, it may be useful to deduce an intermediate position between the educational epistemologies of intelligence and mind. An attempt will be made to infer what a middle position may be on the basis of the descriptions of the other epistemologies and some personal experience of educational practice. No serious attempt will be made to place current educational policies, although a few illustrative examples will be given.

Further distinctions in educational epistemologies.

What use is educational learning? Is it to help develop personal meaning, or to meet the needs of society? Bruner (1974) describes a change in focus towards a consideration of the utility of learning. Should educational learning be described in terms of its utility? Utility in learning could be viewed from two perspectives - utility from the perspective of the individual and utility from the perspective of observers of that individual or from society. An epistemology of mind, supported by a psychology of personal meaning, would certainly include the individual's perspective and, as may become evident below, can also accommodate a social perspective on what is useful. It is suggested here that a middle epistemology would focus primarily on the utility of

learning form the observers' perspective. This middle position would emphasise that knowledge and information are most useful if they can be applied over a variety of situations. Individuals are appliers of knowledge from this perspective, rather than receptacles for it as in a psychology of learning and epistemology of intelligence, or as creators of it as in a psychology of personal meaning and epistemology of mind. An educational epistemology occupying this middle ground places less emphasis upon variations in interpretations of both content and context. In addition, if we were to apply a concept of adaptation from this perspective, it would more closely parallel a biological conception in that it does not include the additional feature of things wished for, or hoped for by the individual. In fact, it may interpret adaptation of the individual in terms only of the values of the observer.

We could refer to this middle epistemology as an *epistemology of problem solving* which may have the following features:

a) Knowledge - including conceptual abstract knowledge - is seen as being only of use when it provides practical solutions to practical and externally (to the student) set problems.

b) Individuals cannot be said to understand anything unless they can show performances which observers in a position of authority or judgment believe to be of value.

c) Individuals' judgments about their own understandings do not count - what they can do is sufficient criterion of judgment.

d) Activity or experience is conceived as being sufficient to give meaning to knowledge (as against, no experience can have a meaning without some element of thought (Dewey, 1917)).

Although not, strictly speaking, seeming to match current thinking in curriculum documents, Chapter 8 will suggest some lack of inconsistency in applying an epistemology of mind, the description of which is aided by a reference to elements of an epistemology of problem solving. An epistemology of mind is in place, but, perhaps, not very firmly as yet. This brings us to the central purpose of this chapter. To attempt to provide a mapping framework which can be used to describe thinking and practice in education and relate it to forms of thinking in psychology. Remember this is not an attempt rigorously and systematically to categorise all particular psychological viewpoints. In this framework, psychology is being approached from

the perspective of educational practice and epistemologies to find the types of psychological thinking which support them, and educational outcomes in understanding which may follow. This is consistent with the earlier discussion of the hierarchy of disciplines, in which it was suggested that higher level disciplines provide specialised descriptions for what has to be explained by the lower levels.

A mapping framework for psychologies, educational epistemologies and educational outcomes.

Figure 7 is an attempt to offer a tool for thinking about the curriculum and the types of understanding which it is likely to foster. Each line represents shifts and emphases that are possible in educational psychology, educational theory and/or policy, and educational practice respectively. The first two have already been described but some additional points will be made below. First, however, the third line will be explained. This is drawn from an Entwistle and Entwistle (1991a, 1991b) study into how students develop understanding while preparing for their final degree exams.

This study set out to use students' experiences of revision in order to clarify the concept of 'understanding'. Student volunteers were interviewed using a semi-structured format which moved from more concrete issues such as use of revision notes to more abstract factors such as what the students believed understanding to be. After transcription, the interviews were analysed. This began by identifying themes within the areas covered by the interviews. These were then further analysed into categories of description. The aim was to carry out a 'rigorous qualitative analysis' to reveal the nature of the emerging concepts as fully as possible. The identification of the themes by the individual researchers was initially subjective. However, an iterative process was adopted involving repeated cross checking with the original data and between researchers in order to crosscheck and agree the themes.

From the data, the authors were able to identify various aspects of the experience of understanding. The aspect which concerns us here is what they referred to as *forms of understanding*. Forms of understanding can be described in terms of breadth, of depth or level, and of the nature and source of the structure. In the context of revision for finals, the structure or nature of understanding may have developed primarily from lectures and books, from a structuring of revision notes, from theories, and from a personal conception of the discipline. Thus forms of understanding can be defined as representing:

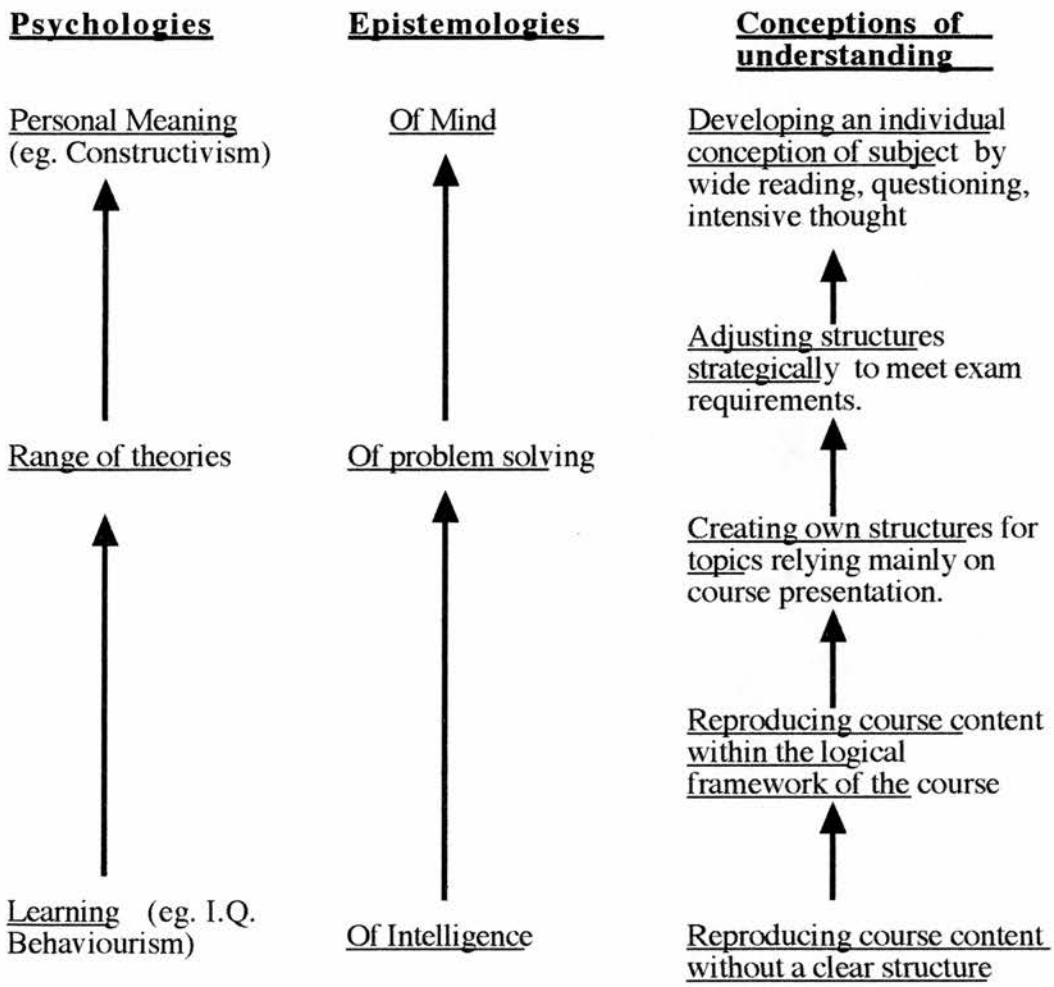

FIGURE 7: A TOOL FOR THINKING ABOUT THE CURRICULUM

..... *distinctive combinations of breadth, depth and structure used by students in developing their understanding, both in the original learning process and during revision.* (Entwistle and Entwistle, 1991b p. 19)

The authors add an important caution

It must be stressed that the way these forms of understanding have been described here is specific to the particular context within which understanding is being sought - preparing to meet the perceived examination requirements. It is also important to recognise that the descriptions are used as analytic categories only. They do not describe individuals; rather they indicate the forms of understanding reached on a particular occasion, or for a specific topic . (p19. Original emphasis)

Five of these analytic categories were identified (Table 1) representing from category A to category E qualitatively greater transformations and elaborations of the original course material and a decreasing reliance on reproduction of the structures presented in the course. It is these forms of understanding which occur in modified form in Figure 7, but are here labelled as *possible conceptions of understanding*. There are reasons for this slight modification of the label.

The first reason lies in the purpose of the figure. Entwistle and Entwistle note that the distinctive forms of understanding appear to arise from the student's intention in engaging in the course and in revision. In a sense the form of understanding which they develop is dependent upon the conception of what sort of understanding is appropriate for them to develop in the particular context. 'Conception' as a term leads more directly to a consideration of the activity of the student, or in considering the activities of the curriculum developer and/or teacher.

In devising and presenting courses, both teachers and curriculum developers may be using conceptions of understanding which they believe to be appropriate for the students to develop. It was an aim in devising this model to allow the activities of students, teachers and course writers to be considered simultaneously and the term 'conceptions' seems to make this possible. Obviously, it is possible that teachers and curriculum developers may have a different understanding of the subject than that which they are promoting in the educational context. That is, their personal forms of understanding of the discipline do not necessarily fit directly to that form of understanding which they are promoting in a particular educational context. The instructional theories which they are applying may lead teachers and curriculum developers to translate their understanding of the discipline into some form specified

Table 1 **Forms of Understanding.**

A.	Reproducing content from lecture notes without a clear structure.
B.	Reproducing content within the logical framework of the lecture notes.
C.	Creating own structure for topics, relying mainly on lecture notes alone.
D.	Adjusting structures from strategic reading to meet exam requirements.
E.	Developing an individual conception of the discipline from wide reading.

(Entwistle and Entwistle, 1991b page 20)

by the instructional theories. For example, Bryce (1993, 1996) notes that targets for the pupils which are specified in the documents for 5 - 14 Environmental Studies and for Standard Grade Science subjects, have a behaviourist ring which he suggests (1993) may be due to the notion that pupils can be moved through a series of predetermined targets which are content focused aligned with a conservative, consensus- driven practice of curriculum development (1996). Instructional theories, not the nature of the discipline itself, seem to be primarily responsible for structuring the target understanding, if Bryce is correct.

The second reason for changing 'forms' to 'conceptions' in the model is a recognition that the categories are being applied outside their original context. That is, they are analytical constructs developed to analyse the ways in which students developed understanding in the context of revision for degree exams. They do not necessarily apply to other contexts. 'Possible Conceptions' seems a less strong term than 'forms' and so more open to reinterpretation. We can use the forms of understanding detected by Entwistle and Entwistle as a starting point for distinguishing conceptions in other contexts and modify them, delete some of them or add to them as appropriate to whatever analysis we are engaged upon.

Some additional cautions

The framework, as presented in Figure 7, may suggest that we should value the upper levels in all cases. That is, that psychologies should be psychologies of personal meaning; that the epistemology applied in education should always be an epistemology of mind; and that teachers, students and curriculum developers should conceive of understanding as developing an individual conception of the discipline and should seek at all times to promote this in themselves or others.

However, this begs a number of questions. What type of psychology of personal meaning? Are all of equal value to us in education? If we adopt an epistemology of mind, does it follow that we can or should promote the development of understanding as individual conceptions from the beginning, or should we take a developmental path towards it? Is there a case for applying an epistemology of action to lower school level education, with a view to progressively moving towards an epistemology of mind? Is it really the role of education to actively promote individual conceptions in understanding (rather than cope with them as an inevitable by-product)? We may go on listing such questions, which are relevant to both explanatory and instructional theories. It is hoped that the following chapters, while not answering theses

questions, will provide a useful framework for beginning to think more clearly about them, from both explanatory and instructional perspectives.

Be that as it may, a number of assumptions are made in drawing up the framework. However, it does not seem to follow that others must share those assumptions in order to make use of it while exploring some curricular issues. In fact, the model could be used to defend positions other than those favoured here, and it can stand as a mapping framework without these assumptions.

Firstly, based on the earlier arguments, the mapping is in constructivist terms. It loads the dice in favour of constructivism coming out on top by using constructivist terminology and concepts. For example, it would be a constructivist position that people act (as, for example, in seeking understanding) according to how they conceive of that task within a particular context. The framework is set up so that all of its components can be explained in terms of the left hand corner, derived from that corner or subsumed within it - whichever seems appropriate as each component is discussed.

Following on from this, it is an assumption behind the model that the upper echelons are superior - not in the sense that they replace the lower ones, but in that they incorporate them. An implication of this is that the lower levels are regarded not so much as being wrong as being limited (or limiting) in their application, at least to education. For example, a psychology of learning may see inherited characteristics as the prime cause of learning ability. A psychology of meaning does not need to ignore inherited factors but it can reinterpret them as constraints upon the forms of meaning that can be constructed. Constraints operate on individuals as they pursue their own goals of meaning, and also upon educators who wish to encourage particular forms of personal meaning. Obviously, we do not always have a knowledge of how to circumvent constraints, and even if we do, it may not always be practical within the time and resources available. This notion of constraints is consistent with some of the comments on plasticity and flexibility made earlier.

Similarly, a student, who adopts a personal goal of trying to reach an individual conception of a discipline by wide reading, active questioning and intensive thought, can cope with situations that an individual who aims to reproduce course content without a clear structure might hope to be competent in - for example, a factual multiple choice test made up of random questions based solely on what is actually written in the notes. In fact, the form of assessment used may be a constraint which limits the individual conception of the discipline within acceptable boundaries. It helps to prevent a too idiosyncratic conception. However, it is doubtful if a student using a

reproductive conception of understanding could write a sustained essay containing interesting and refreshing new perspectives on old problems. We should also note that assessment is not necessarily a good measure of quality of learning, or a source of reward for the approaches to learning which lead to higher forms of understanding (Trigwell and Prosser, 1991).

Again, in line with the assumption of compatibility with biological thinking, this assumption of constraints leads to a further assumption of restraints upon the forms the top level of each line in the model may take. A psychological theory of personal meaning needs to account for the development of personal meaning within a framework of a real physical world and biological, social, cultural, historical (individual and cultural) constraints. It should be a theory of cognitive relativism (cognition is relative to cultural experience), and not be a theory of metaphysical constructivism (the view that there is no reality independent of our knowledge, that we make up versions of reality and for each correct version there is a corresponding world). It may be easy erroneously to embrace some aspects of the latter, as Olson (1992) argues that Bruner has done. Metaphysical constructivism may, or may not, be philosophically justifiable, but with the adaptationally based assumptions argued for earlier, we are not bound to follow it. We may all be biologically and cognitively unique, but that uniqueness is tempered by our need to function within our contexts.[2]

Again, with understanding, there are constraints placed by the context. Students are developing individual understandings of a discipline and so are constrained by the discipline. A useful analogy may be made with the concept of *outcome space* (Marton, Hounsell and Entwistle 1984). This is the range of possible responses to a particular question. The form and structure of the question can be said to influence the nature of the outcome space produced (Pollitt et al 1985). Similarly, we may think of *conceptual space* as the range of conceptions or understandings made possible by particular contacts with a discipline. In outcome space, there is a core of more viable responses to a question. Similarly, in conceptual space, there will be a core of more viable understandings of a discipline. It seems likely that this core would be found among the conceptions of students who seek an individual conception of the discipline

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[2] This should not be interpreted as a philosophical statement about the relativity , or realism, of scientific theories. The form of constructivism adopted here arises from the earlier arguments about mutually constraining levels of disciplines and contexts, and it seeks compatibility across the disciplines in the way in which their theoretical concepts influence and constrain each other. There are issues that philosophers may wish to pursue in this, particularly regarding the status of scientific theories, but this is not of immediate concern. However, the position in this thesis seems broadly in line with Edelman's (1992) description of a biological epistemology, and also with transcendental realism (Manicas and Secord, 1983), which may suggest ways in which this can be further pursued.

by wide reading, active questioning and intensive thought since the target for these activities is the discipline itself and not a second hand representation of it in the course materials.

Boden (1990a) also uses an idea of conceptual space. Her notion is slightly different but compatible. Boden draws upon computational concepts to show that creativity can be described as the exploration and transformation of conceptual spaces. The computational concepts are used to demonstrate the possible transformations. It may be that creativity can be described from the educational perspective as the exploration by individuals of the possible range of understandings in the conceptual space. The creative individual may be the person who does not focus upon the initial understanding a context and past history suggests, but one who explores other possibilities and, perhaps, also looks for links with other conceptual spaces.

An interesting question here is the relationship between viable conceptions of the discipline and viable conceptions of the course representation of the discipline - particularly in its assessment. We have to be careful about the relationship between the core of the outcome space of questions and the core of the conceptual space of disciplines. Certain questions - demanding ones due to their openness, generality or unexpectedness - may favour students who have developed an understanding based upon the principles of the discipline (Entwistle and Entwistle 1991b). There is also some evidence that some exam questions do not favour students who seek an understanding of the discipline, not in the sense that they fail, but rather that they are not allowed to demonstrate their understanding due to time and space constraints (Entwistle and Entwistle 1991b) or that they score no better than other students -the question perhaps tests aspects of the course not generally focussed upon by students (Svensson and Gerrevall, 1991; Trigwell and Prosser, 1991).

Implicit in all this discussion is an underlying assumption - that the framework in Figure 7 can be used in a number of different ways. It can be used- by constructivists - to argue for the greater power of constructivist theories. It can be used to aid in diagnosing some restraints upon constructivism. However, the model is sufficiently justified if it can serve its two original purposes. Firstly, if it can be used, and developed, by educationists to aid visualisation of relationships between psychology and educational theory and practice. Secondly, if it can be used by those working in education to scrutinise consistency in aims, epistemological and psychological thinking.

Also of interest, is that the framework, as described here, seems capable of

incorporating into a single framework, what Greeno (1989) calls alternative framing assumptions for talking about thinking and learning. The alternative assumptions that Greeno identifies are: (1) the assumption of situated cognition (that thinking occurs in physical and social contexts and so implies an agent in a situation, not an activity in an individual mind); (2) the assumption of personal and social epistemologies (thinking and learning are situated in contexts of beliefs about them, these beliefs differ between individuals and social groups and the way in which thinking and learning work are determined by the context of beliefs); and (3) the assumption of conceptual competence (children have a strong potential for cognitive growth and this cognitive growth involves elaboration and reorganisation of knowledge and understanding rather than simply applying and acquiring cognitive structures and procedures).

A further cautionary note seems necessary at this point. It is not an assumption of the framework in Figure 7 that applying an epistemology of mind, backed by an empirically supported and well developed psychology of personal meaning, will inevitably lead to all students conceiving of and developing understanding as an individual conception of the discipline through wide reading, active questioning and intensive thought. The complex range of backgrounds, interpretations and goals of the students will ensure that, in any group of students, a range of conceptions of understanding are likely to exist. However, if course writers adopt the aim to promote this conception of understanding, then they do need to apply an epistemology of mind backed by a psychology of meaning. The emphasis is on apply, since it is not sufficient to allude to this in the course rationale. The content, activities, assessments and so on must also be derived from these sources. Assessments, for example, must be structured in such a way as to encourage a personal structuring and transformation of the subject matter of the course. One might then hope to move the balance in the range of conceptions of understanding held by one's students towards the upper level with a corresponding shift in the actual understandings achieved.

A further point seems worth making regarding individual goals. When one talks of goals, it is easy to assume that what are meant are conscious goals which are arrived at by the weighing up of alternatives. Individuals are described as if they analyse the situation in terms of their own perspective and opt for the conception of the situation and required action which seems reasonable to them. In this sort of description, goals would appear to arise from pure reasoning on the part of the individual. That the goals differ between persons is a consequence of them beginning with different premises.

Goals may on occasion be arrived at in this way . It certainly seems that education - at least at the higher academic levels - seeks to make these occasions more common.

However, it does not follow that they are the norm. In a sense, dealing with educational settings is a form of complex problem solving for the pupil or student, and alternative ways of conceptualising goals are available in this sort of context. For example, Hunt (1991) argues that people do not follow an abstract problem solving principle while dealing with complex problems. Hunt, takes up a position based on Beach (1990) which he maintains fits well with studies into complex problem solving which he has been asked to review within the same volume.

Beach's argument is that problem solving is the unfolding of successive mental representations in which problem solvers rely upon developing a believable mental scenario rather than on analysing alternatives. This may be one way of handling the difficulties of the iterative and reciprocal natures of both understanding and human adaptation. In constructing these scenarios, problem solvers memorise 'tricks of the trade' for dealing with problem situations - they do not develop a single powerful strategy for reasoning. By implication, goals derive from the personal history of individuals and their interaction with the present context. Possibly,if these combine to make it believable for individuals that they can have a conception of understanding in which they seek individual conceptions of the discipline, then this is the goal by which they will operate. Interpretation of the present, representation and anticipation of the future is a consequence of the unfolding of mental representations as the individual pursues a goal of what they expect to be believable outcomes for themselves.

Intentions, moreover, require a component of belief. To intend to do A the agent must believe there is some chance of doing A as a result of her intentions. (Lennon 1990 p. 19).

The implication of this for education, if Hunt and Beach are correct, is that it needs to find the trick of making the goals governing its practice into believable goals for the individual within this narrative.

Concluding remarks.

This and the previous chapters have drawn upon literature from several different fields, fields which some may consider to be independent of each other - namely, biologically, psychologically and educationally based studies of the mind. As Chipman (1986) notes, it is possible legitimately and productively to pursue each without reference to the others. However, as Chipman also points out:

These fields can be seen as offering ..... different perspectives on a common scientific problem: explicating the nature and process of human mental function. They

can provide independent converging sources of evidence that increase our confidence in scientific conclusions. (p204)

An attempt has been made to bring together these differing perspectives through a exploring ways of conceptualising human adaptation. A particular concept of adaptation has been reached which sees adaptation as occurring, not always in synchrony, across layers or levels of contexts. A case has also been made that these theoretical fields, along with educational practice itself, are converging in providing a milieu in which understanding emerges as a phenomenon and concept of increasingly pressing interest. This convergence lies in the common theme of individuals (as brains, as psychological subjects, as students) constructing their own representations of the world around wishes, hopes, believability and so on. Subjective interpretations are made of the world and the character of these interpretations is influenced by the anticipations of outcomes that the individual holds. The manifestations of this convergence are found in the current moves towards constructivist psychologies, an epistemology of mind and educational research into individual conceptions. A framework has been offered in Figure 7 which attempts an initial illustration of these relationships.

This framework incorporates an assumption of the type of constructivist psychology which is most promising - a psychology of personal meaning operating within certain constraints. Individuals face problems of adaptation in social settings such as educational institutions as they do in society and the physical environment. Understanding is an adaptation and as with other adaptations can be more or less perfect. Understanding is not an all or nothing phenomenon (Nickerson 1985). The degree of perfection of adaptation can be viewed from two perspectives - as viewed from observers of a particular individual and as viewed by the individual himself. That is from *outside in* or *inside out.*

Interest in the varying perspectives that individuals can hold is a centre piece of schools of qualitative research such as phenomenography (eg Marton 1981). Phenomenography focuses not on the world directly but upon peoples' ideas about and descriptions of experience of the world. Descriptions and statements about the world comprise a first order perspective. Descriptions of experience or ideas about the world comprise a second order perspective.

It generally emerges that peoples' descriptions of experience can be grouped into sets of qualitatively different categories. (See for example Säljö 1979, Van Rossum et al 1985 for conceptions of learning). The central theme of Marton's paper is that knowledge about such phenomena as conceptions of learning cannot be attained

independently of context and content. Therefore, we cannot categorise individuals according to their conceptions, since these are likely to vary across contexts. However, it is argued that the set of categories itself is stable and can be generalised between situations.

A problem, which has to be conceptually grappled with in developing an explanatory description of understanding, is that outcomes in a group of individuals (the range in forms of understandings which develop) depend to a degree upon the range of conceptions of understanding among those individuals. Second order descriptions form a source of concepts for the explanation of outcomes we make in our first order descriptions and statements about understanding. Explaining understanding requires us to incorporate both first order and second order perspectives in some way. In other words, an explanatory theory of understanding needs to describe how the concepts individuals describe themselves as having of the forms of understanding a context requires, contribute to the forms of understanding which they demonstrate to the observer in assessments, experiments or other forms of observation. Forms of understanding which may not seem adequate to the observer, may nevertheless, be in line with what the individual conceives to be the form of understanding required, or which they believe it is possible for them to develop.

However, it is not clear at this stage if the conceptions of understanding identified by the Entwistle and Entwistle study comprise a complete set of phenomenographic categories. We noted the authors' own caution regarding this. It was also not intended to be a phenomenographic piece of research. However, the parallells with conceptions of learning are suggestive and perhaps a tentative conclusion that they represent the skeleton of such a set is warranted. This gains some support from the fact that other studies (Burns et al 1991, Tan and Novak unpublished) - although differing in terminology - bear some interesting resemblances in their findings to the Entwistle and Entwistle study.

If so, the idea of conceptions of understanding is interesting on two counts. They can be used not only to describe the goals and purposes of the students in a particular context, but also those of the curriculum writers and the teachers. Conceptions of understanding provide a useful tool for analysing and describing the teaching learning process from its conception in the purposes and goals of the syllabus right through to the activities of the teacher and students. We can examine the whole process for consistency in this respect. What conceptions of understanding are implied by the wording and structuring of the syllabus, its assessments, how it is taught and how it is learned and how well do they fit together?

As a preliminary example of this, a group of MEd. students from the primary sector were asked in a seminar to use the framework to analyse some of the 5-14 documents they were using at that time. They felt that there is a certain inconsistency in some of the 5-14 documents. For example, some students expressed an opinion that the opening rationales in the documents were phrased in terms of an epistemology of mind and implied the development of understanding in the form of individual conceptions of the subject matter. However, the course material expressed in the strands seemed to these students to reflect an epistemology of problem solving and, at times, even an epistemology of intelligence (see also earlier discussion of Bryce, 1993, 1996) with conceptions of understanding somewhere towards the reproduction end of the spectrum.

Some secondary teachers, at the same seminar, expressed the opinion that, despite the implications in Standard Grade literature that they should allow students to work at their own pace on Resource Based Materials in order that they take more responsibility for their own learning, the way for students to obtain the best passes and for teachers to cope with how they are themselves monitored, lies in a return to more teacher led and dominated modes of classroom management which involve a rote 'drumming -in' of facts.

The significance of this may depend on the point of view one adopts. It may be, as noted earlier, that we can only move students in stages towards achieving independent conceptions. It may be, however, that efforts to deliver any educational philosophy falter upon some inconsistencies in application of that philosophy at any point from its origin in educational policy, its development into a curriculum, its practice by teachers, and its reception by students. The time now seems to be right to come to grips with this particular group of issues as conceptual tools for dealing with them become available.

These conceptual tools come from the milieu formed by those aspects of psychological research emphasising individual representations, flexibility, adaptation, personal goals and in those aspects of educational epistemology emphasising the capacity for all to think, the construction of knowledge and the possibility of improving one's ability to master academic material. Much of this type of thinking goes at least as far back as Dewey (1917), but psychology and educational epistemology have now shown themselves capable of giving us the conceptual background needed for what may be the most appropriate aim of education in a democratic society - to promote the abilities of our students to participate as free thinkers in all aspects of society (Boots and Reynolds, 1983). It is now possible to contribute to this milieu by beginning to

develop a concept of understanding which acknowledges that outcomes depend, in part, upon a range of conceptions of what is required in a context.. This, in turn, can lead to ways to help us to think through how more effectively to support the aspiration implicit in an epistemology of mind - namely, that it is possible to improve the mastery of academic material by any student. The next chapter will attempt to provide a conception of understanding which is consistent with the above described emphasis in psychological research and educational epistemology, and so provides an explanatory framework within which instructional aims can be pursued more effectively.

Chapter 5
A framework for thinking about understanding

The previous chapters established the foundations for creating a framework for thinking about understanding. Several themes have been identified which contribute to underpinning such a framework -particularly, the idea of mutually constraining disciplines, the need to find ways more powerfully to relate research based theory to educational practice, the distinction between explanatory and instructional theories in education, and the need to deal with issues of human adaptation.

This chapter introduces the arguments which lead to that framework. Two strategies will be used in this. Firstly, to engage in a degree of linguistic analysis. This is not intended to be at a philosophical level, but it does seek to illustrate various senses of understanding which need to be included in a framework for describing and thinking about it. Secondly, an attempt will be made to build upon the previous chapters and the points made there about understanding. It will be argued that there is a convergence in these various aspects which allow a convincing framework to be established.

A simple linguistic analysis

Let us try to clarify and integrate some of the various meanings of 'understanding.' It is argued that each of the senses has its own validity, and that a complete conceptualisation of understanding requires us to keep them all in mind.

The first sense of 'understanding' can be approached by considering the statement, "It is my understanding that ....." This is a meaning of understanding which implies something particular to an individual. It is that individual's interpretation of context or a particular aspect of that context. In this sense, a person always has an understanding of the context. We can call this a personal understanding which a person brings and takes from a situation - even if that something is a sense of bewilderment. This may also be the sense of the term which is implied when writers talk about the growth of social understanding, or the growth of language understanding, or other developmental uses of the term. At any rate, understanding in these cases is clearly not one of either fully understanding or of not understanding. It is open to variations in depth or level, and to variations in interpretations of what is the case or what is being meant.

Personal understanding has a history - a history which lies in the past experience and beliefs that an individual brings to a context. These affect how they interpret the present. Everyone has personal understanding. It is part and parcel of being an individual human being.

The second meaning of understanding can be highlighted by such phrases as, "A person's understands if ....."; Understanding involves being able to....." Understanding, in this sense, has specifications which are independent of any particular individual. These specifications may refer to normally acceptable behaviour. "He doesn't understand how to behave at the table". They may refer to assessment performances which can be taken as demonstrations of understanding. "The student will demonstrate understanding of X by offering an explanation of X." This use of understanding to refer to those situations in which an individual performance is in some way specified by others than the individual involved, we shall call a target understanding.

The third sense of understanding is encapsulated in a number of phrases. "This person understands." "This person misunderstands (ie. there is an understanding but it is wrong)." This group of people display a variety of forms of understanding of the topic" These evaluative statements bring to the fore the fact that, in this sense, understanding is about the various types of relationship which are possible between the personal understanding the individual brings to, and develops within, a context and the target understanding presented there. They are personal understanding to target understanding relationships, some of which are valued by society, or particular sections of it, and some of which are not.

There is a trap here for education. We may make value judgments about personal understanding to target understanding relationships in our explanatory theories. However, for the purpose of explanatory theories, the above analysis suggests that all such relationships are in need of explanation. The place for value judgments is in instructional theories. We decide which type of relationships between personal understanding and target understanding are those which we value, and we structure our target understandings and teach towards them in ways which we hope will facilitate those relationships. Also, in some cases, perhaps all academic cases, target understandings may themselves embody values - the value of being objective for example. These values may be part of the explanandum for explanatory theories, in so far as they affect the relationship a person has with the target understanding. We also tend to judge understanding (or lack of it) in terms of the values embedded in the target understanding or in the type of personal understanding to target understanding

relationship which we favour. However, this is using instructional theories. In an explanatory theory, all types of relationship are relationships involving understanding, since both personal understanding and target understanding are involved. In this thesis, we have the difficult task of acknowledging, and making explicit, any values which are embedded in a target understanding, without subscribing to, or denying, those values. All types of relationship between personal understanding and target understanding need to be within the compass of explanatory theories for the sake of completeness, which should, ideally, be contemporary and historical in that they explain how something is at the moment, but also how it got to be like that through time (Ryan, 1970).

In a discussion of literacy, Baynham (1995) encounters similar issues. Literacy, like understanding, is often presented as characterising those who have education and those who have not. He also develops a framework in which, instead of one literacy, there are diversities of actual and potential literacies. He notes that definitions of literacy are always shaped by ideology. In our instructional theories, definitions of desirable personal understanding to target understanding relationships will similarly be ideologically based.

Another useful concept from literacy is that of 'common ground' (Gibbs,1995). Common ground is the sharing of specific information about one another's knowledge, beliefs and attitudes. It is a requirement for making sense of figurative speech. It could also be said to be a requirement for facilitating certain kinds of relationship between personal understanding and target understanding. Common ground in this case would exist if the goals of the person to be educated and of the educator were similar in both description and in the criteria by which they are being judged by both of them. No common ground exists if the student sees the target presented by the educator as being irrelevant to his or her goals or adaptational needs. Another way of putting this is to argue that common ground could involve some sharing of values between personal understanding and target understanding, which facilitates some forms of relationships between them while making other forms of relationship less likely.

The following, somewhat extreme examples, may serve to illustrate how we can still talk of understanding in an explanatory sense, across a variety of personal understanding to target understanding relationships

Example 1

Imagine I am out walking and meet Jack. My opinion of Jack is that he always talks a

lot of meaningless drivel and jargon, that he is boring in the extreme, and that he has nothing to say which is of any use to me personally.

As I pass Jack, he says some words which I hear, but do not really register and quickly forget - the reason being that it is Jack who says them, and I have already decided that what he says is of little interest or use.

My understanding of the event (part of which is the content of the understanding target that Jack placed before me) is that it is an event of little significance, devoid of meaningful content (from my perspective), and one which I could have avoided without personal consequences or loss.

Of course, from Jack's point of view, I have completely failed to understand the content of his message or the intention behind his delivery of it.

Example 2

Imagine now that you meet Jack when out walking and meet him in a manner so outwardly similar as to make no difference. But you have no real feeling for Jack - positive or negative - and are ignorant of any importance his work may have. However, people have said that what he says is worth listening to and likely to be of personal significance to you.

As a consequence, you strain to listen to and remember what he says and hear the words,

"I've just heard that there has been a major crash."

You continue on your way, feeling slightly uneasy, wondering if anyone close to you has been hurt and if you should have done anything to reduce the risk of people being involved in an accident.

Have you understood the event (including the intentional content of Jack's message) any better than I have?

Example 3

In this instance, Fred, the local bank manager, meets Jack - again the circumstances are outwardly similar. He knows that Jack is a financial advisor and expert on the stock market who is not slow to impart information to his acquaintances which he deems to be important to them. You respect his knowledge and expertise and always seek out the importance for yourself. No prizes for guessing that Fred interprets the

message,

"I've just heard that there has been a major crash,"

in a completely different light. He hurries away to explore the significance of the stock market crash for his personal portfolio of shares and for his customers. He has grasped correctly, from Jack's perspective, the meaning of the words and the intention behind them. His personal understanding relative to this event, most closely resembles or matches the target understanding.

In these examples, the first two personal understandings seem not to exist, or to be a misunderstanding. Relative to the intention within the target, and the values embedded within it, they are not the sort of personal understanding to target understanding relationships one may normally accept as illustrative of involving understanding. However, that is akin to adopting an instructional stance. They still need explaining, and that explanation can still be in terms of personal understanding to target understanding relationships.

Some more information. In example 1, you have to know that I am a hermit who has renounced all worldly wealth and spend all daylight hours trying to hunt for berries, roots and other wild sources of food. I am engaged in this when I meet Jack, who persists in treating me as if what he says is important to my future and will make a difference to my life - something which I have long ceased to believe. Given that background, the interpretation of the context from my personal understanding seems to be more adaptive than previously. It is valid in my terms. For it to cease to be dominant in the way I interpret the situation, I need to be persuaded to change my background assumptions and to re-enter the world where money matters.

In the second example, I have cast you in the role of a safety officer, who believes in the value of the monetary system, but you have little insight into how it works. You do not have sufficient common ground with Jack to understand his message and so you have missed its the metaphoric meaning. Instead, you have supplied a meaning from your own background which is inappropriate in every sense - both from your own perspective, since you worry needlessly, and from Jack's, since you missed the target's intended meaning.

Each of the three outcomes can be explained, and the explanations are in terms of personal understanding to target understanding relationships. However, my personal understanding differs from that intended in the target because Jack and I have little or no common ground. Yours differs because you lack sufficient common ground with

Jack.

Of course, I can be taken to represent the anti school, demotivated type of pupil. For me to have sufficient common ground with teacher Jack, I have to undergo something akin to a conversion experience in which I suddenly see school work as being important. Jack needs an instructional theory which will show him how to bring that conversion about.

You represent the pupil who is keen to learn, but hasn't got a sufficiently developed awareness of what learning in educational settings requires. You have not developed sufficient common ground with the educational enterprise and the understanding targets it sets up. Jack needs an instructional theory which shows him how to build that common ground. Fred is the pupil with sufficient common ground to hit the target. As Ford (1979,1980a) argues, a distinction can be made between a student's ability to analyse, synthesise or evaluate information, and the same student's personal acceptance and valuing of the ideas which are being manipulated in these ways.

The three individuals in the examples are interpreting the situation on the basis of the personal understanding they already have - that is, in line with their own concerns and interests. Or, to put it another way, their interpretations of the situation are influenced by the adaptations which they have previously made within their life milieu. The way that they relate to the information imparted by Jack is in a sense pragmatic (White, 1984).The way in which people perceive social situations and reason about them involves solving what, for them, are practical problems (see Read, 1983). They, therefore, focus only on information which is directly relevant to these problems and are content to act on a limited amount of evidence. Even Fred may be doing this. In education, the learner may be provided with a lot of information which is not immediately relevant - or apparently not relevant. The information is expected to be used and combined in comprehending complex theoretical arguments or in forming one's own arguments. It may be that the type of common ground required in education has significant differences with that of other social situations (see also Granott and Gardner, 1994). This question will emerge again in the analysis of target understanding and in its relationship with personal understanding.

The above analysis suggests that a complete explanatory framework needs to view understanding as a complex range of possible relationships between the personal understandings of individuals and the target understandings provided by culture and the social institutions within it. Instructional theories will seek to promote those relationships which we deem to be most desirable on educational and ideological

grounds. However, the earlier discussion of human adaptation would suggest that individuals seek to relate to target understandings in ways which are adaptations from their point of view - that is, in line with their wants, beliefs and goals. Is this conclusion in line with our previous analysis?

Building upon the previous chapters

It was suggested earlier that understanding is a two sided phenomenon. On one side it is an internal phenomenon: it is that part of individual functioning through which the person models and/or interprets the external environment. On the other side, it is an externally specified prescription of what the person must do to cope with a situation. This external specification may be formally stated, as in educational settings, but it may also lie in the nature of physical and social settings, or in the way in which language is used in communication.

In the first sense, an individual always has some understanding of the surrounding world. There is always some perception or cognition of one's surroundings and one's place within them. It is not a case of having or not having understanding, but rather it is a question of how understanding is possible (Boden, 1990b). What does the brain or mind do when understanding the world around it? What features of the world is an individual able to access and in what ways is he or she capable of using those features? Thinkers who are interested in the role of the brain or mind (or computers) in supporting Intentionality or representation can sometimes be found using the word in this sense (eg Madison, 1982; Searle, 1983) and many can be found to use other terms such as 'awareness', 'consciousness' representation and 'meaning' in senses which seem interchangeable with the above definition of understanding (eg. Gazzangia, 1992; Karmiloff-Smith, 1993; Martin, 1981; Oatley, 1985; Young, 1986).

Most of us do not remain satisfied with this sense of the term understanding for very long. We may argue that understanding has to be about something more than a mere reference to our ability to perceive and/or represent the world in general. It is certainly true that even those thinkers who have used terms such as understanding or representation in general terms, move on quickly to apply their discussions to specific examples, such as language, orientation in the physical world, social situations, scientific theories, and so on. Understanding and the other terms above are, after all, Intentional terms.

As we take this step, more pressing questions arise for most of us. For example:

1) What understanding does a person have?
2) Why is a person's understanding different from that developed by other persons?
3) What does a person need to do in order to understand a sentence, idea, theory, concept?
4) Why does this person understand this sentence, idea, theory concept ?

It is at this point that confusion can begin. The first two questions assume that a person always has some sort of understanding. Understanding is not something we do or do not have (Nickerson 1985). The fourth leads easily to the assumption that a person can either have or not have understanding, and is, perhaps, the question which we tend to ask most often in education. As noted in the linguistic analysis, in education we may tend to define what understanding is in some way; for example, to solve problems, answer exam questions. If these definitions are not met, we then tend to assume that understanding has not been attained.

This is illustrated by the approach taken in one major research project (Gardner *et al.*, 1992,1993; Wiske, 1997) in which a performance view of understanding has been developed. In this view, understanding is defined by being able to show particular performances (understanding performances) which are regarded by the researchers as being evidence that it has been achieved. The performances which characterise understanding vary across domains, but they can still be defined in advance of the individual being placed in that domain (see also, Perkins, 1997; Perkins and Blythe, 1994; Perkins *et al.*, in press; Perkins and Unger, 1989; for background to this position). This performance view of understanding is discussed more fully in the final chapter, where a comparison is made with the framework developed in this thesis.

The research team has managed to apply this approach to classroom education by encouraging teachers to adopt the concept of understanding performances, along with planning their teaching around understanding goals - that is, goals in the form 'the aim of the lesson or topic is that pupils will understand that.....'. However, it falls short of being, and possibly does not intend to be (but see Perkins, 1997 and Chapter 8 of this thesis), an explanatory theory. It is an instructional theory because it does not explain how the learners actually achieve (or don't achieve) understanding. It assumes only an inside- to-out direction of fit and at that overlooks the personal history that the individual brings to the situation.

It was noted earlier that learners have a causal role in their own learning through how they interpret the context, and this is not part of the picture in the above project. As a result, it restricts our comprehension of the nature of understanding and so our ability

to deliver ever improving educational opportunities in a changing and complex world.

It is argued here that the third question is the important one as it allows us to link both the outside in and inside out aspects of understanding- particularly if it is modified by asking

"What does a person already understand, and therefore need to do in order to understand a new sentence, idea, theory or concept , and what does a person already understand that leads sometimes to a different understanding from that intended in the target?

This can be put another way. "What is it in the development of personal understanding which leads to personal understanding to target understanding relationships which we, from an instructional perspective, find less acceptable and at odds with the way we value those relationships, or at odds with the values embedded within the target understanding itself?"

The notion that persons always bring an understanding with them to a situation leads to viewing understanding as multilevelled and multifaceted and capable of different degrees of completeness (Nickerson, 1985; Welbourne, 1986; Woods and Barrow, 1975; Ziff, 1972). At times, understanding seems far removed from our conscious selves as subconscious processes take the lead - for example, in semantic processing (Lockwood, 1989). At other levels it involves us in awareness and appreciation of connections - how new information integrates with old (Welbourne 1986).

In trying to answer this modified question and to deal with the multifaceted nature of understanding we have to attempt to handle conceptually, and explain, an individual with his unique personal history , the structure or processes which surround that person, and the interaction between the two. Again, we are trying to deal with the complex nature of human adaptation through a concept of understanding which is multilevelled and multifaceted. The level of complexity which has now been reached cries out for a simplifying framework.

Specifications for the framework.

An attempt can now be made to bring together the themes from this and previous chapters to set out the specifications for this framework to encompass the meanings of understanding.

a) From the discussion of educational epistemologies, it emerged that understanding (now called personal understanding) can be more than accumulation of knowledge. It involves varieties of qualitative transformations by individuals of knowledge, information and experience, and as it develops it is influenced by a wide range of factors from both within and outwith the immediate context. The factors which influence the development of personal understanding include the individual's past relationships with life contexts, interpretation of the current situation, and personal goals.

b) It also emerged that as a concept, understanding leads us to consider the types of interaction between all the actors in a particular context such as an educational setting.

c) In the discussions of levels of research and biological and social complexity, it was argued that understanding (personal understanding) is possible because of the species specific biological and psychological mechanisms which human beings possess. However, the particular personal understandings which emerge are explained by considering the particular physical and social environments (target understandings) that individuals encounter during their lifespans and the relationships which they have with these targets.

d) Of the factors that influence the development of personal understanding, it was suggested that individual interpretation of context was one which could be regarded as a focus for a theoretical analysis which aims to deal with the complexity of the phenomenon. The problem is approached by asking the question of how the other factors (biological and contextual) influence or constrain interpretation of context. That is, how they constrain or influence personal understanding-target understanding relationships.

e) In discussing Intentional states and teleological functionalism, it was suggested that personal understanding is an Intentional state which will have some adaptational value to the individual - at least from that individual's own perspective.

f) Given the above, personal understanding cannot accurately be described as a state of mind which a person does or does not display or possess. However, it can appear to be so when discussed in relation to certain goals that others may have for that individual - for example, teachers for a pupil. However, it was noted that personal understanding is really a multilevelled and multifaceted phenomenon which is capable of different degrees of completeness relative to a context.

g) It was noted that, since no two individuals meet identical context as they develop, or perceive them in the same way, personal understanding will be unique for each individual. However, as in (a) above, limitations or constraints are placed upon this uniqueness by biological characteristics and by the norms, social codes, and language used by society, by the physical aspects of the environment, and by the life history of the individual concerned.

The framework in outline

Figure 8 shows the basic outline of a framework for thinking about understanding which has been derived from the above discussion. It is based on the assumption that personal understanding (as the individual's interpretation of the world around) is not a phenomenon which occurs only in educational contexts. From the individual's perspective, it is an adaptation which begins and develops from the youngest years onwards. What does the individual adapt to in natural situations which will lead to a unique personal understandings? Generally speaking, a person needs to interpret the natural objects which are encountered, along with humanly constructed concepts, theories, descriptions of the physical world, not to mention human relationships, and so on. These represent a range of target understandings. One way of putting this, it to say that the objects of understanding in this sense are a combination of what Popper calls 'World 1' and 'World 3' (Popper, 1972; Popper and Eccles, 1977).

'World 1' in Popper's scheme refers to the world of physical objects, and 'World 2' to the world of subjective experiences while 'World 3' is the world of products of the human mind. This final world includes scientific and artistic works, technology, language, theories of self and death, and so on - what Durkheim might call, 'collective representations' (Farr, 1987).

Personal understanding as an individual interpretation of what has been encountered would then belong to 'World 2'. What has to be understood or interpreted (the target understandings) would derive from both Worlds 1 and 3. The contents of Worlds 1 and 3 are, of course, immense - too numerous for any individual to encounter them all. There are also objects and/or phenomena in World 1 which no one has yet managed to understand or explain. There will likely be phenomena in World 1 which are yet to be discovered. World 3 is also full of material which will not be encountered by most of us, much of which would be unintelligible if we did meet it.

One problem when studying understanding as individual interpretation (personal

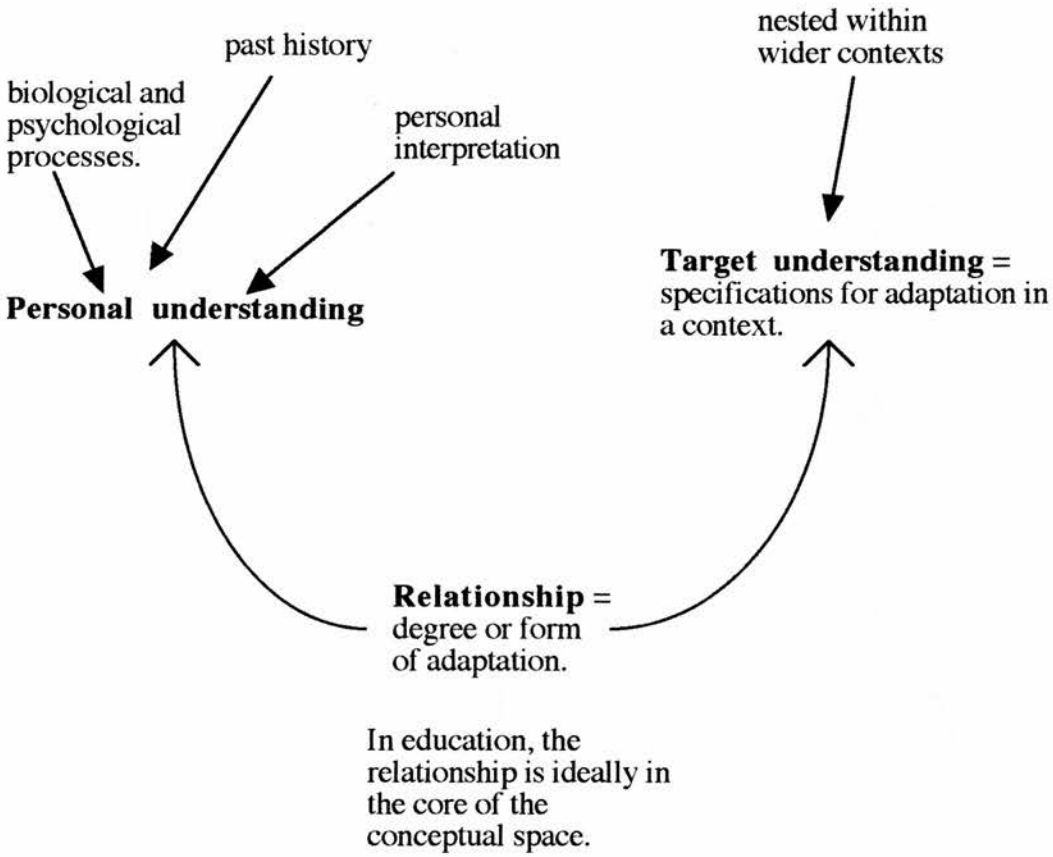


FIGURE 8 : BASIC FRAMEWORK FOR EXPLAINING UNDERSTANDING, AND EDUCATIONAL INSTRUCTION FOR UNDERSTANDING.

understanding) in a particular situation is separating out what aspects of Worlds 1 and 3 which the individual has encountered into those which are relevant and those which are not. In concrete terms, for example, how do we decide when family background is a factor in understanding the Theory of Evolution and when it is not? Alternatively, when do we have to consider the understanding of alternative theories (eg. a Creationist Theory) as a hindrance to understanding of the theory currently being offered to an individual as an explanation of a phenomenon? When should a lack of being prepared to accept a theory become regarded as being a lack of understanding?

Perhaps we can begin to get to grips with these issues if we adopt a similar tactic to that which Bronfenbrenner (1979) adopted when dealing with the complexity of social systems. He analysed social systems as consisting of nested subsystems. Similarly, the target understandings which derive from Worlds 1 and 3 can be thought of as consisting of a number of nested sets. In this way, we can begin to examine how a target understanding is positioned within wider contexts, and we can make decisions as to how wide a field of data our explanations need to draw upon.

The terminology of Set Theory can be used to aid this thinking. The totality of Worlds 1 and 3 would be the Universal Set for understanding. This set contains various levels of subsets which individuals will encounter, and which will be of interest to various academic disciplines. For example, if we wish to study the Politics of Nationalism, we will be interested in mapping out the features of the Universal Set (ie. of World 1 and World 3) which affect the personal understandings of, say, national identity we may find in the French, British, Italians and so on. We might call these sets the French National Set, the British National Set or whatever seems appropriate, and we could map out what they had in common and how they diverged. We would also need descriptive terms and conceptual tools to explain the personal understandings of individuals from each nationality.

How would this apply to education? The target understanding could begin to be analysed as follows (see, Figure 9). There is the Curriculum Set which contains those features of the Universal Set which have become regarded by curriculum planners (perhaps deliberately, perhaps through want and usage) as worthy of inclusion in the experiences of students as they pass through the educational system.

The curriculum set is obviously a restricted set compared to some of the others which individuals may encounter, but it offers the possibility of including some features which many of them would not otherwise meet. The boy from the African plains or Morningside can be introduced systematically to the World of Atoms and Molecules.

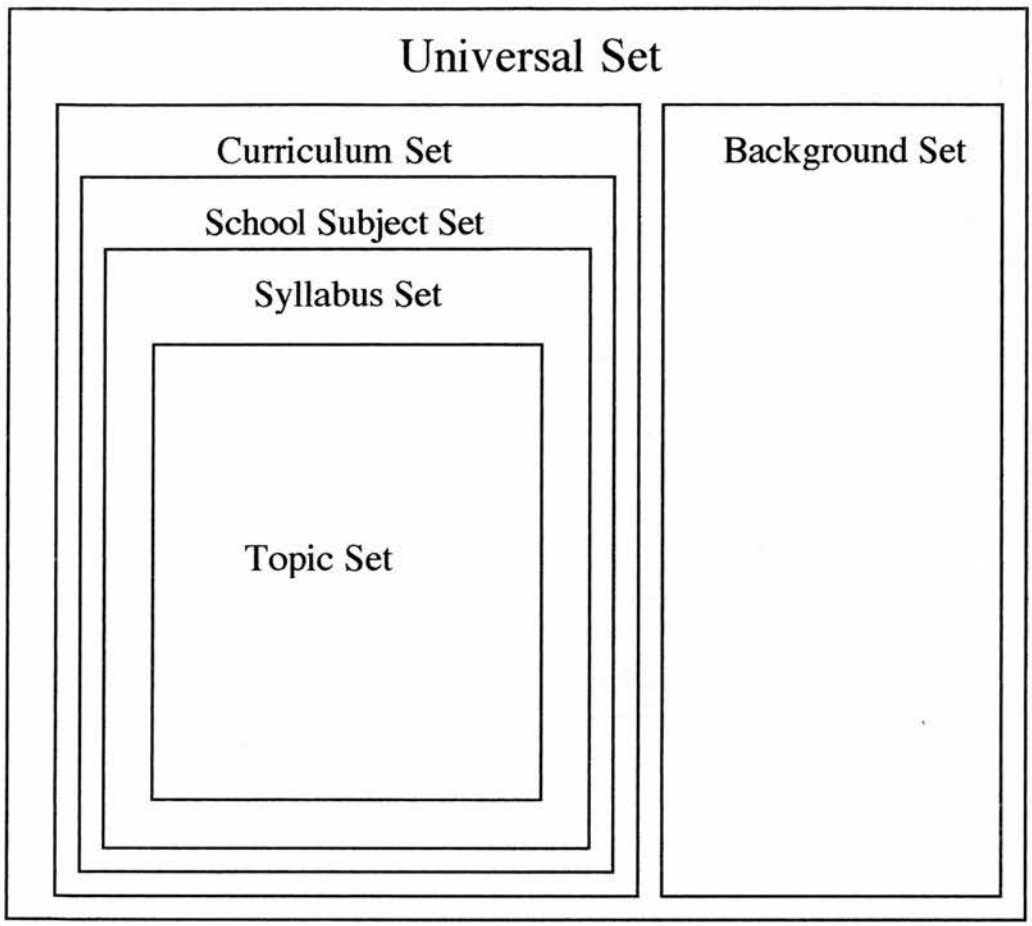


FIGURE 9: NESTED SETS THROUGH WHICH TO POSITION TARGET UNDERSTANDING.

A point to note about any subset of the Universal Set is that they often - perhaps always - contain as part of their contents from World 3, rules for individuals to adopt in developing their personal understanding. These rules would be one way in which values become embedded in a target understanding as discussed earlier. Formal sets, such as the science set, the law set, the civil service set, and more informal sets such as friendship groups, neighbourhoods and so on, seem to have norms and codes to which individuals are expected to conform when interpreting how they should act. Some rules of what adaptation is expected, or usual, or desirable from the perspective of those who administer or who have developed the target, are part of its composition. These rules, codes or values may have historical roots.

The Curriculum Set obviously has these types of rules or conditions for personal understanding built into it. There are expectations for behaviour, set texts to read and, of course, there are assessments laid down which individuals have to undertake. Perhaps, the main difference between most curricular sets and that of the earlier described project of Gardner and his colleagues (1992, 1993), is that the latter have tried more systematically to encourage what they would regard as real understanding- a deeper level in the multifaceted, multilevelled phenomenon of personal understanding?

Obviously, the Curriculum Set is, itself, divisible into subsets, one of which is the School Biology Set. We can ask questions about these subsets. For example, what are the rules for personal understanding which are part of their constitution? Also, what relationship do they hold to the subsets within which professional scientists operate (see Claxton, 1991)? We can also ask how these rules are interpreted by pupils and teachers.

Let us try to summarise the framework by defining the concepts which seem pertinent to a study of understanding and school subjects.

1) Understanding can be thought of as a two sided or two directional phenomenon. On the one side is personal understanding with an outside to in direction of fit - that is the organism processes from the outside that information or aspects of the context which it is biologically able to access (there is also a possibility that this also involves conceptual ability and variations in the interpretation of that information). On the other side, understanding has a specification which is independent of any individual - an inside to out direction of fit. This specification involves both physical and social features of the world. It consists of all the physical objects and phenomena in the world, all constructions of human minds such as theories, language, formal and

informal rules of behaviour, artistic works, and all physical and social events. The totality of everything which exists to be understood is an ultimate target understanding which can be described as the Universal Set.

2) The Universal Set is by definition immense, and many aspects will pass unencountered or unrecorded by any single individual and so will not be accessible to personal understanding. At any rate, its sheer size means that no person can attain universal understanding.

3) No two individuals will encounter exactly the same aspects of the Universal Set in their lifetimes. Therefore, we can expect each individual's personal understanding to be unique.

4) When studying understanding, we have to be careful to detail those aspects of the Universal Set which seem relevant. We can then discuss personal understanding in relation to those relevant features. One way of doing this is to define subsets of the Universal Set and, then, to detail their features. This is possible for a range of disciplines and types of study. Those which seem relevant here are defined below.

5) The Curriculum Set is that total subset of the Universal Set which exists in an educational institution and which may in some way affect individuals when they are present in that institution.

6) The Background Set may be used to detail those features which do not belong to the curricular set but which the students (or other subjects) may have encountered and which may have an effect on how personal understanding develops in relation to the topic of the research study.

7) The School Subject Set is that subset of the curricular set which individual students may meet in a particular school subject, such as science, mathematics, biology, chemistry, and so on.

8) The Syllabus Set is a subset of the School Subject Set which has been prescribed - usually in written form - as being the requirements to which students should be exposed during their time in a particular course at a particular age.

9) The Topic Set is a subset of the Syllabus Set which is actually presented to the students by the teacher. That is, the teacher's interpretation of the syllabus and the methodology used in delivering it with regards to a specific syllabus topic.

Figure 9 represents the way in which a target understanding can be positioned within these nested sets. We may normally expect that most of the factors having greatest impact on the development of personal understanding of an educational topic will be found in the most immediate sets - the topic set and the syllabus set. However, the above framework allows us systematically to consider other possibilities, when it is thought to be necessary. Also, we may feel in analysing data, that other sets require to be added to the list of those which seem to be relevant - a peer group set, perhaps? At any rate, it is necessary to analyse a target understanding carefully in terms of which sets may be primary for the way in which the individual is interpreting the situation. In educational explanations, we may need to compare the intended target with the actual target. This would be one way of assessing the effectiveness of our instructional theories. The variations in relationships between personal understanding and target understanding may sometimes be due to responses to different actual targets, rather than be due to different responses to the same intended target.

For example, Hounsell (1984), notes that the studies described in Marton, Hounsell and Entwistle (1984) suggest a gap between reproduction and understanding and equates understanding with meaning. The implication is that those students who, for example, treat lecture content as something to be memorised for assessment rather than something to be interacted with, are not concerned with meaning. In one sense, this is obviously correct - they have not analysed the lecture material. However, in another sense the meaning (or alternatively, the adaptational significance for some individuals) of the material is to treat it as an object for memorisation.

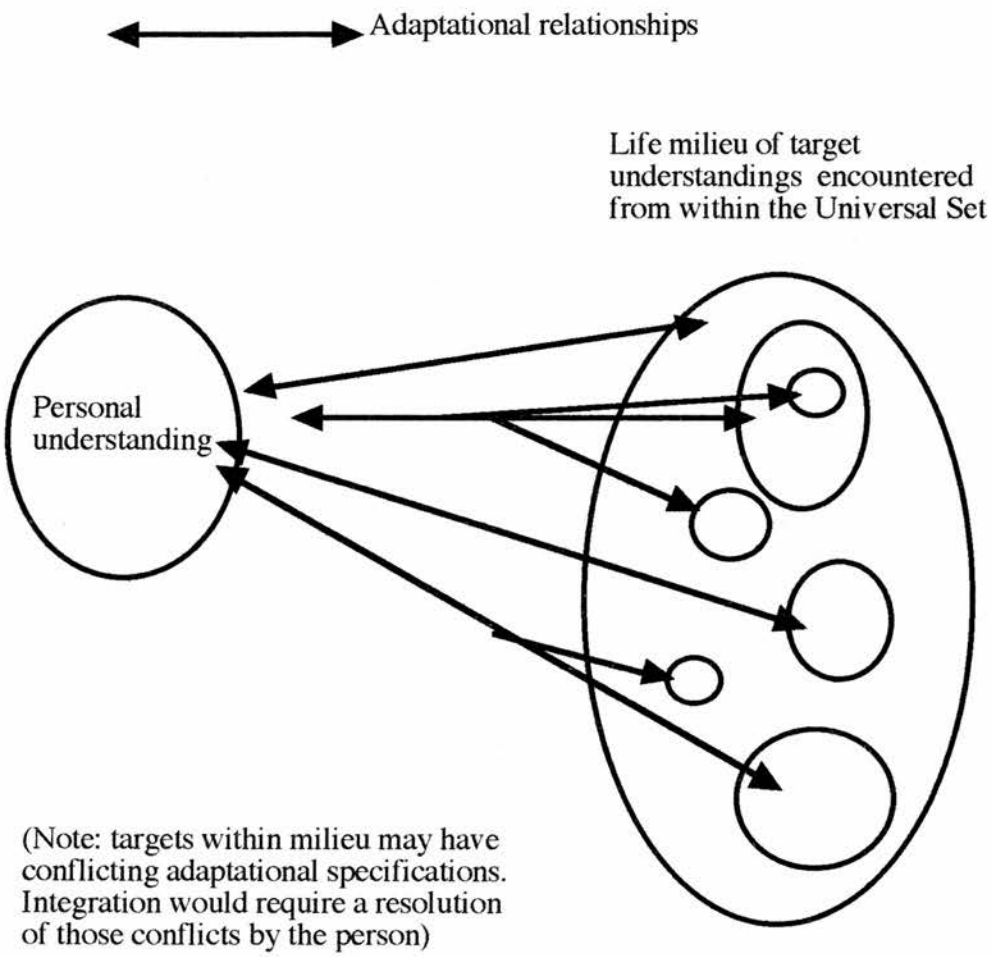
It can be seen that this picture of relationships between personal understanding and target understanding is compatible with that which was derived for human adaptation.

Figure 6 (page 44) which illustrated the complex nature of adaptation can be modified (Figure 10) to show the relationship between personal understanding and target understandings as being one in which the targets form a total milieu, but a milieu which may not have the same specifications built in to each part of it.

Adaptation, the framework and alternative views of understanding.

The previous discussion highlights a recurring difficulty (generally, and in this thesis) in talking about understanding. Are we referring to personal meaning and sense making, or are we thinking about the mastery of a particular body of knowledge and way of thinking? These different questions can be seen as reflecting two different constructivist perspectives - individual constructivism and social constructivism

FIGURE 10 : INTEGRATED AND UNINTEGRATED PERSONAL UNDERSTANDING TO TARGET UNDERSTANDING RELATIONSHIPS.



(Marton and Booth, 1997). Individual constructivism is concerned mainly with the cognitive activities which create personal meaning, whereas social constructivism is concerned more with the way in which cultures build up accepted meanings and understandings from shared experiences. A classroom is one place in which experiences are shared. However, as Valsiner and Man-Chi Leung (1994) note, knowledge construction is

.....simultaneously personal and social, as it entails the interdependence of the active person with the socially organised world. (p215)

Similarly for understanding. The framework offered in this thesis attempts to deal with this duality of problem questions by making it possible for us simultaneously to view understanding in both individual and social terms. Perkins (1992) also seemed at one point to be moving towards a view of understanding along these lines. The classroom was described by Perkins, at this time, as providing an overt aspect of understanding, but there is also an internal aspect with its own structure.

Understanding is a multilayered thing. It has to do not just with particulars but with the whole mindset about a discipline or subject matter .....(It forms) a larger mosaic that has its own spirit, style and order.... Understanding somehow goes beyond possession of knowledge. (p. 74,76)

Again, the complexity of the study of understanding is emphasised. White and Gunstone (1992) also emphasise the complex and multidimensional nature of understanding with the consequences that it is unique for each individual, and is not something which can be said to be possessed or not possessed. The framework offered here seems correct to consider understanding as consisting of both overt and internal aspects along with the relationships between them. Within this framework, personal understanding can be regarded as resulting from the combinations of adaptations a person has made at the psychological level to the range of social and cultural contexts encountered during his or her lifetime. Explanations of misunderstandings (eg alternative conceptions, Bell *et al.*, 1985; Driver, 1983; Driver *et al.*, 1985), or of why different forms of understanding are developed (Entwistle and Entwistle, 1991a, 1991b), of why some students are unreflective about the content of lectures and merely memorise it (Hodgson, 1984), or even of total failures to form any recognisable form of understanding, may sometimes derive from conflicts of adaptations between contexts (eg. a conflict between adaptation to everyday contexts and educational context). For example, in discussing alternative conceptions, Hewson (1988) writes:

the individual has constructed a model of meaning that is different from that propounded by orthodox science, and that the student is committed to that explanation

because in some way it is intelligible and meaningful to her, in other words, it works. (page 34)

Two points about adaptation are worth re-emphasising at this juncture. Firstly, it has been noted that adaptation to a particular context does not imply uniformity of form of adaptation between individuals. For example, Entwistle and Marton (1994) develop the idea of *knowledge objects* to explain the sort of representations which accompany understanding when revising for exams at university. A knowledge object is a sort of framework which the student constructs in order to guide explanations in essay answering which - at least for those students in the study - is flexible enough to be applied to different sorts of questions or audiences (Entwistle, in press). A knowledge object also features points which act as triggers for pulling in other related information. The construction of knowledge objects could be thought of as being a form of adaptation to those academic contexts which require the ability to formulate arguments within a discipline of knowledge and concepts. However, the knowledge objects constructed by a group of students in response to an academic course are by no means identical, and not all students experience such knowledge objects. Also, adaptations do not imply a perfect fit between person and context. Adaptations only have to be viable in a context to count as adaptations to that context. If this was not the case, we would only count those students who obtain full marks in all forms of assessment as having an adaptation through personal understanding to a context. The important point is that varieties in personal understanding as adaptations <u>across</u> contexts and <u>within</u> particular contexts are part of the data for explanation in theoretical conceptions of understanding, and that viability in one context may contradict viability in another.

This point refers to the role of target understandings in adaptational relationships. In so far as target understandings have rules for engagement, they lay down some adaptational specifications. In everyday, or less formal, contexts, these specifications may be no more than conventions or norms for interpreting the world or for how to behave. However, in more formal contexts such as those found in education, the specifications for adaptation will usually be more prescriptive.

This will be considered in more detail later, but examples of the types of prescriptions that target understandings contain may be a need for coherence in personal understanding, an ability to use given facts and concepts in explanations, to solve particular classes of problems and so on. It seems to be these prescriptions within target understanding that are described by the idea of understanding performances (Gardner *et al.*, 1992,1993). However, we shall see that understanding performances also have a role to play in describing the relationships between personal understanding

and target understanding.

There is, however, a complication. Target understandings do not always come direct to the student. Teachers have a role in interpreting the target and in presenting it to the students. In Scottish schools, subjects usually have an explicit syllabus, but students may also perceive implicit targets based on the teaching they experience and on the assignments they are set. At university, and perhaps in the schools of other countries, the formal definition of the syllabus may be less rigid and provides only an outer ring for the target, because teaching staff are judging students by the central, but often implicit, meaning of academic discourse in their discipline. Again we find an important part of the explanandum - the nature of target understanding in terms of both its structure and of its presentation.

Finally, there is the range of relationships which can occur between personal understanding and target understanding. In terms of the particular target, some of these relationships would be more adaptive than others. To be able to show the understanding performances which a course specifies would be one indication of viable adaptation. The development of forms of understanding would be another way to describe the degree of adaptational relationship between personal understanding and target understanding. As noted above, we may need to consider personal understanding across other contexts to find reasons why particular forms are developed. However, the explanations may also derive from the structure of target understandings and/ or their presentations. Explanations of relationships involving misunderstandings or apparent failure to understand may also derive from both target understanding and personal understanding.

What this suggests is that, relative to a particular target understanding, there will be a space of outcomes of relationship with personal understanding. This brings us back to the idea of a conceptual space as being the range of possible understanding relationships arising from an individual's encounters with an academic discipline. It was suggested that a conceptual space would have a core of more adaptationally viable outcomes. This adaptational viability can now be seen in terms of both the individual's perspective and that perspective of the values, rules and specifications within the target. The core of the conceptual space (at least where the aims of explanation are limited to the immediate target and seem adequate within that limit) would be those personal understanding to target understanding relationships where personal understanding reaches some degree of compliance with the specifications in a target understanding. Explanatory theory in education seeks to explain how, or why, individual personal understanding to target understanding relationships fit, or do not

fit, into the core of conceptual space.

An implication of this arises for how we conceptualise the relationship between explanatory theory and instructional theory. An instructional theory will have been used, at least implicitly, in setting up a target understanding and for defining those relationships between personal understanding and target understanding which we regard as evidence for the target having been complied with. Instructional theories often, if not always, have set the agenda for our attempts to explain understanding. They also encourage us to think of understanding as a 'have or have not' condition, despite cautions to the contrary (eg. Nickerson, 1985).

Another advantage of the framework developed in this chapter, is that it avoids the above situation by including instructional theories as part of the data to be covered by an explanatory theory. When we can explain why instructional theories have not led to viable relationships between personal understanding and target understanding, we can perhaps derive better instructional theories which will, in turn, provide more data for our explanatory theories. Explanatory and instructional theories can have a mutually beneficial relationship within this framework.

Summary

Personal understanding is multi-faceted and multi-layered and has developed as the person encounters the range of contexts in society. This leads to it being adaptive to varying degrees across the range of contexts encountered during the lifespan of an individual.

A context can be described as presenting a target understanding to an individual. The degree of specification as to what counts as adapting to this target varies in terms of detail and rigidity.

There is a range of possible relationships between personal understanding and target understanding some of which are more adaptationally viable in terms of the most immediate target than are others.

In the case of those target understandings found in academic contexts, we can think of the relationships between personal understanding and target understanding as forming a conceptual space. For explanatory purposes in education, the core of the understanding relationships in this conceptual space comprises those in which the

adaptational specifications of the target understanding are in some way complied with by personal understanding. We seek to explain why, for an individual, a personal understanding to target understanding relationship lies, or does not lie, within this conceptual space. From an instructional perspective, the aim is to bring such relationships within this core of the conceptual space.

In explaining why core relationships are achieved, or not achieved, we may need to consider not only the nature of the target and its presentation, but also the adaptational relationships between personal understanding and other contexts the person has encountered.

On the basis of the above, it is difficult in explanatory theories to specify the nature of understanding in simple terms, as it includes this full range of interactions between personal understanding and the target understandings encountered in a life milieu. There is, in consequence, no immediately obvious way of summarising the full range of possibilities which would, in some sense and relevant to a particular context, be counted as being understanding. However, in an instructional sense, we may characterise understanding as the core of the conceptual space in which the relationships between personal understanding and the target understanding presented in an educational setting in question achieve some sort of match. This core of the conceptual space is also the useful focus for explanatory theories in education. This will be explored more thoroughly in subsequent chapters. In this chapter, we have introduced the contrast between personal understanding and a variety of possible target understandings. In the next two chapters, these concepts will be discussed in more detail, separately, before examining their practical significance.

Chapter 6
Personal understanding

There are a number of important and complex issues which would need to be discussed in great detail to provide a full account of personal understanding. This is beyond the scope of this thesis. Such a task is made even more difficult by the ways in which the issues impinge upon each other. Nevertheless, it is necessary to give some flavour of the work that needs to be done, and to provide some possible pointers as to how it might be accomplished. In an effort to keep some distinctions between the issues, and also inform the reader of where the discussions are heading, the following is a list of questions to which a theory of personal understanding must either provide answers at some point, or suggest ways in which answers should be built up from other sources and/or sought by research.[1]

Most of these questions are too complex to be fully answered here. Rather, what is intended is to draw upon relevant theories which provide an insight into how answers to the questions would help to clarify a concept of personal understanding. An attempt will also be made to justify personal understanding as an appropriate concept in educational explanation. The defining, or redefining, of understanding as involving a concept of personal understanding will allow us eventually to deal with the uniqueness of understanding, with its possibility for refinement and extension, with its multifaceted and multi-layered nature, and with the general complexities of human understanding which, as noted earlier, is missed by too narrow a definition of understanding. In considering the following questions, the concept of personal understanding is invested with more meaning, and placed within the hierarchy of explanation discussed earlier.

1) Precisely what are the distinguishable features of personal understanding? What counts as personal understanding and what does not count? Is there one type of personal understanding, or can discrete categories or varieties be identified?

2) In what ways is the definition of personal understanding compatible with the current state of physiological research and theory? How does physiological activity make personal understanding possible? Also, how do we reconcile biologically

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[1] In attempting to clearly explain the place of emotion within cognitive functioning, Lazarus (1991) lists the questions which any theory of emotion must answer. The questions in this chapter are derived from Lazarus's list in a way which hopefully will help to bring out possible relationships of personal understanding as a concept in an explanatory theory of education to psychological functioning.

derived, species universals with the variability derived from social or cultural sources?

3) How does personal understanding relate to consciousness? To what extent is it dependent upon unconscious mental activity?

4) How does the concept of personal understanding relate to concepts such as the individual, personality, and so on, which infer some consistency in a person in developing through and moving between environmental contexts?

5) How does personal understanding relate functionally with the 'trilogy of the mind' (Hilgard, 1980) - that is with cognition, motivation and emotion?

6) Can we distinguish any general principles by which personal understanding develops? What are the sources of influence?

7) How does personal understanding relate to long-term adaptational outcomes such as subjective well-being, social functioning and health? Is it possible to influence the development of personal understanding towards such outcomes?

What is personal understanding?

The earlier discussion highlighted the difficulty of providing a simple definition of understanding. It was suggested that understanding (in an explanatory sense) is the full range of interactions between personal understanding and the target understandings encountered in a life milieu, including failures to interconnect. There is, in consequence, no immediately obvious way of summarising the full range of possibilities which would, in some sense and relevant to a particular context, be counted as being understanding. Similarly, personal understanding has no simple, 'either/or' definition. It is seen as comprising whatever interpretations the individual has built up of both self and the range of contexts encountered in the life milieu - interpretations which serve some sort of adaptive purpose within that total life milieu, but which are not necessarily consistent across different aspects of that life milieu. It is only when we move to instructional definitions, that understanding begins to take on some sense of being, or not being, 'achieved'. Even in this sense, however, there are ranges of viable understandings which make up the core of a conceptual space.

The key to coping with the complexity of factors that influence the development of

personal understanding is to work from the individual's interpretation of context. This is now becoming a more established position in educational research, with many writers arguing that the learner's perspective of the learning task should be included in descriptions of how learning occurs (for example, Case, 1975; Entwistle, 1987a, 1996; Marton and Svensson, 1979; Messick, 1985; Neumann 1987; White, 1988). Also, in both educational research and in the wider field, it has been established that the conceptions or models that individuals have of the immediate task, of themselves, and of the information which they already hold, all influence engagement in the present (eg. Anderson and Ortony, 1975; Bloom, 1976; Halford, 1993; Happs, 1985; Kemler-Nelson, 1984; Marton and Säljö, 1976b; Norman, 1983; Poulin-Dubois and Shultz, 1988; Roazzi and Bryant, 1992; Säljö, 1979; Shotter, 1982; Wittrock, 1978).

This being the case, it should be possible to point to some concrete cases in which individual interpretations of the task, or of task requirements, have led to contrasting behaviours or actions by persons within the same situation. An example of this is clearly found in the work of Marton and Säljö (1976a, 1976b). These authors were interested in focusing on differences in the actual content of learning, rather than in differences in the number of 'bits' of learning acquired.

A highly significant aspect of learning is in our opinion, the variation in what is learned, ie. the diversity of ways in which the same phenomenon or concept is apprehended by different students . (1976a p. 16)

The subjects of these studies were university students. They were asked to read an article with a strong argument, having been told that they would later be questioned about it. This questioning began with a request to summarise the article briefly, and was then followed by more content specific questions. Marton and Säljö found that they could identify two qualitatively different approaches to this task which led to qualitatively different outcomes.

The approaches which the students took can be described in terms of their intentions. Some students had an intention to cope with the task so as to reproduce the points they expect to be asked about, and so they engaged in what the authors called *surface level processing* based on rote learning strategies. Other students wished to make sense of the intentional content of learning material. That is, they set out with the intention of understanding what the author meant (1976a). This approach utilises *deep level processing* in which the argument is related to previous knowledge, other topics and personal experience. The intentions adopted by the students are not seen as characteristic of them as individuals, but depend upon the ways in which they interpret

what is expected of them on a particular occasion (1976b).

Entwistle and his colleagues (1979) noted that Marton and Säljö's work described learning in terms of three elements: intention, process and outcome, and that the descriptions of levels of processing included both intention and process; arguing that the terms *'deep and surface approaches'* were preferable. These terms come into common usage and can incorporate similar concepts coined by other researchers (Biggs and Rihn, 1984). Entwistle (1987a) summarises approaches to learning in terms of the following characteristics:

Deep Approach:

Intention to understand
Vigorous interaction with content
Relate new ideas to previous knowledge
Relate concepts to everyday experience
Relate evidence to conclusions
Examine the logic of the argument

Surface Approach

Intention to complete task requirements
Memorise information needed for assessments
Treat task as an external imposition
Unreflectiveness about purpose or strategies
Focus on discrete elements without integration
Failure to distinguish principles from examples.

(p. 60)

These characteristics are all present in a particular situation, but an approach to learning would be recognised by having some of the features from the appropriate set.

The applicability of the concept of approaches to learning has been demonstrated with several different learning tasks (eg. Hodgson, 1984; Hounsell, 1984; Laurillard, 1979, 1984; Ramsden, 1984) and with secondary school pupils (Selmes, 1985, 1986). The concept also seems to be applicable to primary school children's approaches to learning to read (Francis, 1984). It has also influenced or been applied to the analysis of research problems and/or results in a number of other research projects covering such diverse areas as training of nurses (Trigwell and Prosser, 1991), learning in the third world (Wilson, 1985), study methods used by university students in relation to various forms of outcome and/or success (Entwistle and

Waterson, 1988; MacLellen, 1996; Thomas and Bain, 1982; Van Rossum and Schenck, 1984), preferences by students for methods of instruction (Jones and Jones, 1996) and children's thinking about their own learning (Pramling, 1988).

Similar concepts have been applied in parallel to, but are not derived from, approaches to learning. In particular, the distinction between the goals which learners approach learning tasks as being either *performance goals* or *mastery* (learning) *goals* (for example, Ames, 1992a; Dweck, 1986; Greene and Miller, 1996), or student involvement in learning as being *task involvement* or *ego involvement* (for example, Graham and Golan, 1991; Nicholls 1984). Bong (1996) notes that although these latter two dichotomies are essentially equivalent, it is not clear if they are rooted within the same theory of intelligence and she argues that it would be helpful for work to be done on their integration. A similar caution applies in any comparison of these concepts to that of approaches to learning.

The wide range of studies making use of the concept of approaches to learning and its similarity (on the surface at least) to other concepts, underlines the importance of formulating a concept of personal understanding. This importance lies in two areas. Firstly, it comes from the theoretical stance taken by researchers in the phenomenographic tradition from which the concept of approaches to learning derives. This was touched upon in Chapter 4, but will be considered in a little more detail here. Marton (1981), in setting out this theoretical position, begins by distinguishing between two types of research perspective. The first he calls a *first-order perspective* in which the researcher orientates towards the world and makes statements about it. A *second-order* perspective is one in which the orientation is towards people's ideas or descriptions of the world based upon their experiences of it. Marton claims that this distinction has nothing to do with any philosophical position regarding the existence of an objective reality, or with a questioning of the reality of experience. The aim is to find and systematize forms of thought in terms of which people interpret aspects of reality - aspects which are socially significant and which are at least supposed to be shared by the members of a particular society.

Marton sees this type of research aim as being complementary to the more common type of first-order research. More particularly, Marton places second-order descriptions in Popper's World 3, along with the first-order descriptions obtained by science. If he is correct in this, once these descriptions have been formulated, they become - in the terms used here - part of the universal set and potential objects for personal understanding. The challenge from this for any formulation of a concept of personal understanding is in maintaining the complementarity of the two perspectives

by achieving a first-order description of personal understanding, which does not shut the door on there being a field for second-order descriptions to explore, and does not deny the validity of those descriptions as they relate to the actual experiences of individuals. It is not clear if Marton would subscribe to this formulation, but Booth (1992) notes that phenomenography very rarely contents itself with a mapping of descriptions of experience as there is usually also a question to be answered, and she makes the point that phenomenography may be used by other disciplines which need its results in order to deal with their own questions.

This brings is to the second aspect of the importance of approaches to learning in conceptualising personal understanding. They provide a clue as to how it may be systematically approached - namely, by exploring and clarifying the nature of the intentions, processes, and outcomes, which the individual may be following, using, and achieving, through approaches to learning. Some of the issues will resurface when relating personal understanding to cognition, motivation, and emotion - particularly in exploring how intention, motivation, and emotion may be related. However, the dual importance of research into approaches to learning compels some consideration of how we can regard experience, in order to maintain a compatibility between second-order descriptions of that experience within first-order descriptions of intention, process and outcome.

An important feature of experience is the subjective sense of irreversibility that accompanies it - experience has an arrow of time. Experience comprises, in part at least, memories of distant and more recent past, sensations and anticipations. (Horrowich, 1987). The person anticipates that some things remembered will, at some time, be remembered as having occurred even further into the past, that the things sensed at present will be remembered, and that at least some of the anticipated experiences will happen at some time in the future. A problem in both education and psychology is that some concepts demonstrate a tension or ambiguity as to whether they represent processes or states. Terms such as thought, belief, and understanding have a '*process-product ambiguity*' (Moravcsik, 1990). A similar problem exists with phenomena such as emotion (Lazarus, 1991).

A possible source of the above ambiguity is the purpose for which we are trying to describe experience. Depending upon by whom, and for what purpose, experience is being described, the explanatory concepts can slip between what may be called,, *at time* definitions, based upon the sensation component or other aspects in the present, and *through time* definitions which are based upon memories and anticipations or other aspects related to the past or future. Experience then appears to exhibit an *at*

time/through time duality in which it flicks between state and process. This resembles the confusion that can exist in adaptation if one forgets that the context is not static. Adaptation, as noted earlier, is a relative term requiring a description of the context to which it refers. Both explanatory and instructional senses of understanding have a history in time, but tend to treat it differently. Instructional senses of understanding tend to focus primarily on 'at time' definitions or descriptions, since they usually focus on a single, immediate context which has, or has not, been successfully adapted to in terms of the instructional theory being applied. Any 'through time' perspective seems usually to conceive of a person's learning as developing through these contexts of adaptation in a progressive manner. The immediate target understanding is seen as building upon, or extending, the previous targets. Explanatory theories, on the other hand have to attempt to incorporate both 'at time' and 'through time' descriptions, as they seek to explain particular outcomes in terms of the person's *life milieu.* The target understandings do not necessarily have an inbuilt logic. The 'through time' aspect in lies, in this case, in the individual's own life history and in a range of diverse contexts. How can explanatory theories of personal understanding begin to deal with this?

Jaques (1982) has carefully examined the relationship between subjective experience and objective time. He makes a distinction between the psychological time of past, present and future in which human experience is located and the objective time of the physicist. The latter is made discontinuous by making it a succession of points on a line. Psychological time is a time which encompasses

> *...prediction and intent-which contains the conceptions of goal-directedness and of what will happen in the continuously present field of past-present-future which co-exist in the interaction of memory, perception, desire and anticipation. (p.87)*

Jaques develops this description into what is, perhaps, an over elaborate two-dimensional view of time, but we do need to be careful in how we handle the relationship between psychological and objective time. Psychological time appears to be with us as a function of being living creatures. It is not a measure of time, but a feature of a feeling of existing in a present, with a perceived past, and an anticipated future. We could debate as to what degree forms of psychological time are shared between cultures and between species (see for example, Toffler, 1984). Most of us probably feel that psychological time speeds up with age. However, it will suffice here to follow the above authors in noting its existence in interactions of memory, sensation, desire, anticipation and goal -directedness - at least, for our culture. This suggests that, when we use terms referring to psychological or Intentional states, we are not referring to point states which are locatable in objective time, other than by

relating them to the form which a context took at a particular moment in objective time. Experience is continually moving on and so instructional (at least, when they are restricted to 'at time') descriptions of understanding (and perhaps, some descriptions of psychological phenomena, such as emotion or memory) become dated immediately. Explanatory descriptions need to try to find ways of being descriptions in psychological time. There is some inadequacy in our conceptual language, which may be shared with other research activities - a tension between languages of states and of process or flow (Halliday and Martin, 1993). For example, if we take memory as one of the components of experience, we can argue that, through the way it influences anticipations and the experience of sensations, it plays a role in the way it is itself built upon or modified. Memory is, therefore, constantly being modified by its own role. It is also difficult to point to memory structures, memory processes, anticipations, and so on, as being the prime cause in the growth of memory. All of these components appear to exert some influence on each other.

This argument applies to approaches to learning. Educational institutions set aims and targets - there are items they wish the learners to deal with in particular ways. That is their function as educational institutions, regardless of whether they see the prime aim of education as being to teach facts, learning skills or meaning. However, as the research on approaches to learning has shown, learners bring their own perspectives to the educational setting and so follow intentions of their own. The curriculum aim may be to enable learners to interact with content, to relate ideas to previous knowledge, and to promote the other characteristics of the deep approach, but the learner may still take the surface approach and this, as has already been noted, may be due to past influences or to influences outwith the immediate context. From the perspective of psychological time descriptions, it appears that the surface approach can be as much a feature of personal understanding as the deep approach. Both involve the active interpretation of what the context is believed to require.

This suggestion has some support from the previously quoted study by Entwistle and Entwistle (1991a, 1991b). The forms of understanding at the base of their hierarchy seem to result from a surface approach, those in the centre involve a more strategic approach, and those at the top depend on a deep approach. It is only a short step in psychological time descriptions to include in personal understanding those outcomes which do not seem to have immediately obvious relationships with the present context. This was illustrated by the story of Jack in Chapter 5. It is through psychological time descriptions that we come to see why some of the characters lacked sufficient common ground either to agree the significance of the intended meaning of Jack's utterance, or to comprehend it correctly, but that they can still be said to have a

personal understanding of the situation. Personal understanding refers to how we have come to participate actively in the psychological time of experience, so that we interpret ourselves and the contexts in our life milieu. It is a characteristic of being human, and of having Intentionality, to live in psychological time and to develop personal understanding.

This use of the term personal understanding to include what results from any active participation in a context, has an interesting parallel in an argument made by Bereiter and Scardamalia (1989). These authors distinguish between *intentional learning* and *incidental learning*. The assumption is made that all experience can have learning as an incidental outcome. Intentional learning on the other hand refers

...cognitive processes that have learning as a goal rather than an incidental outcome. (p363)

Intentional learning is offered by Bereiter and Scardamalia as an alternative term to *autonomous learning* (Thomas and Rohwer,1986) to avoid the implication that there is necessarily freedom from external direction. Intentional learning can occur in both teacher-directed and self-directed situations. They also argue that whether intentional learning occurs

.....is likely to depend on both situational and intrinsic factors - on what the situation affords in goal attainment opportunities and on what the student's mental resources are for attaining those goals. Thus, focusing on intentional learning provides a natural way of coordinating the two relevant research traditions - the tradition dealing with learning situations and the tradition dealing with learning skills. (p363)

Bereiter and Scardamalia go on to argue that, in school situations, learning can degenerate into schoolwork. The student's aim is to complete the task. This can arise because children have little conception of what learning as a goal-directed process involves, but the do have a conception of what work is about.

Studying is work of course, but that is not the point. The work that characterizes classroom life may have originally been conceived with learning goals in mind, and it may even achieve some learning objectives, but from the standpoint of the students, doing schoolwork is what school is about. It is their job, not attaining learning goals. (p377)

The consequence is that student effort goes into schoolwork rather than the pursuit of learning. This view sits comfortably with the contrast between deep and surface approaches, with differing forms of understanding, and also with varying personal experience. Most of us at some time have probably been in situations in which our

only desire was to complete the task set, but we have later been able to recall and recognise the significance of a previously isolated fact which we noticed in that situation. In the sense that it has been remembered and recalled later, that fact has been incidentally learned. Perhaps more importantly, in Bereiter and Scardamalia's analysis there is an implicit layering of possible outcomes as measured against the objectives of the educational enterprise in question. This layering of outcome will depend upon what the student brings in terms of goals, skills, and prior knowledge, along with the structure of the situation, which also may, or may not, facilitate the student's use of these, or facilitate their development in ways compatible with learning goals. In conceptualising personal understanding, we need to show how students contribute to this layering of outcome relative to the context .

Personal understanding, as a phenomenon of experience, is logically unique for each individual, since each has a different psychological history. Even identical twins do not share a spatio-temporal identity and so cannot experience reality in exactly the same manner (Hermans, 1976). Even where dialogue occurs about a particular topic, this only shows that the participants have constructed and revised their understandings to make this possible - not that their understandings are identical. (Duffy and Jonassen 1991). Some insight into this can be gained by returning to phenomenographic research.

A number of features of this type of research are particularly striking. Firstly, there is an apparent exchangeability in the descriptions of the students' intentions and the subsequent outcomes. Students who intend broader, deeper, or more structured, outcomes by and large seem to attain them (or at least describe outcomes in the same terms), and students who seek only to memorise some basic facts, seem to achieve nothing more than this. There is an interdependence of intention and outcome which can appear almost inevitable, as Svensson (1976,1984) has noted in subsuming them within the concept of *skill in learning* (1984). This work also distinguishes between the task set and what the person brings to it, and seeks to describe the quality of interaction between them. Svensson argues that 'skill in learning' should be viewed and described in terms of qualitative changes within a developmental perspective. This would also apply to a concept of personal understanding.

Secondly, there is the emphasis on structure of outcome. For example, the study which looked at students descriptions of the outcomes of revision for degree finals, revealed what seems to be a hierarchy of forms of understanding (Entwistle and Entwistle, 1991a, 1991b). At the bottom of it, there is little emphasis on structure, but thereafter there is a progression to the apex where an individually structured

conception of the discipline, attained through wide reading, is to be found. What is interesting here is that the structure is described by both researcher and student, as relating to some sort of target - lecture notes, article text, and the discipline.

Thirdly, there is an emphasis on the individuality of the learning process. Marton and Säljö (1984) note that a difference in outcome inevitably implies a difference in process. Outcome and process are perceived as having a direct relationship in which, if we know the process, we can predict the outcome - clarification of process is explanatory of outcome.

Fourthly, intentions, processes and outcomes do not place students into particular categories, but merely describe them relative to a particular context. Students may exhibit different levels or categories of intention, process and outcome in different contexts (see Svensson 1976, 1984 for more detailed discussions of most of the above points). Finally, the term understanding tends to be reserved for the outcome of what the student has done and achieved, despite the apparent interchangeability of intention, process and outcome in explaining each other.

These points can be taken to indicate a tension between psychological time phenomena and objective time descriptions. The researcher is bringing before the student particular targets, and then seeks to analyse the way the student responds to them. As a consequence, these targets tend to be treated in isolation from the continuous field of experience in the psychological time of the student. As a result, apparent discrete components of intention, process and outcome emerge. This seems to have a certain inevitability, given the current limitations of our explanatory language. Our explanations currently tend to be relative to a particular context in objective time. At present in educational explanation, we need to develop the concept of context itself, along with the concepts by which we attempt to describe experience (concepts such as intention, process and outcome), if we are going to improve our explanations of understanding.

The problem arises from the following. In Chapter 1,we followed Scharfstein (1989) in noting that context is defined as whatever is relevant to the purpose of our explanation. It was also suggested in the understanding framework, that researchers have to make judgments on how far to expand the context of their investigation to explain a particular personal understanding. In treating personal understanding as adaptational, we noted the need to remember that adaptation is never final. Context and organism are forever changing in time.

The context in which research is being conducted, since it has evolved independently of a particular individual, changes in objective time. Intention, process and outcome, being concepts referring to aspects of experience, develop in psychological time. The problem that needs to be tackled is finding better ways of explaining how personal understanding, as adaptation between person and life milieu, involves the tracking by psychological time phenomena of contexts described in objective time.

A possibility consistent with the understanding framework offered in this thesis, is to avoid thinking of understanding solely as the outcome of a particular approach to learning. Rather, we should regard intention, process and outcome as being aspects of personal understanding. We differentially focus on these aspects according to our purposes when relating personal understanding to its context. For example, imagine some students undertaking a new course - say in psychology. These students have developed through their own individual backgrounds (contexts in the broadest sense) to the point where undertaking this course seems a possibility. They now enter the context as defined by the course material, method of teaching, the teachers aims and assessments. Their individual contexts are being expanded to include the context demarcated by the course. The students commence the psychology course with some form of personal understanding which derives from their past experiences, with anticipations or expectations of the course and of what they will get from it. This personal understanding will now begin to interact with the target understanding presented within this expanded context.

If we look more closely at the logic of this situation, we find that the intention the student *is able* to exhibit must depend to an extent on what outcomes have occurred and on what processes have developed relative to previous contexts. The intention *actually* exhibited, from among those which are possible for the student, depends upon the motivations and perceptions which arise in this context. Thus 'personal understanding' is an interaction of those aspects we call intention, process and outcome, and which mediates between a person's life history and broader social context of the individual and the narrower educational context within the school, college or other institutions. There is a constant flow in which intentions arise from outcomes and interpretation of what is required, so that processes are selected by the individual from those which are possible, leading to a new outcome (which may only be a slight modification of that at the beginning), and so on.

Similar analytical ideas have been applied by other authors. For example, van Geert (1994) in an analysis of development of both biological and psychological processes makes the following comment:

If anything like a basic developmental mechanism exists, it must be an iteration. An iteration is a process which takes its output as its new input, produces new output, which it takes as input, and so on , ad infinitum. (p14)

Bandura (1978) advances a view of reciprocal determinism, in which natural causes are seen as overlapping with effects and are separable only in a temporal sense or for the convenience of analysis. This seems compatible with a view of flow and with the interdependence of intention, process and outcome. Lazarus (1991) also uses an idea of psychological flow in his description of the relationship between cognition and emotion.

Feedback from the emotion process, which includes the causal cognitive activity and the emotional state itself - having been perceived and further evaluated by the experiencing person - also influences subsequent psychological states and processes, including emotion, in a continuous psychological flow. (page 127)

The question now arises as to what could drive this flow in personal understanding. Authors who have studied this issue (for example, Biggs, 1984; Biggs and Rihn, 1984; Entwistle and Ramsden, 1983; Fransson, 1977) generally find an association between learners who have an instrumental motivation (to pass the course or avoid failure) and the surface approach, and between learners who have an intrinsic motivation (to actualise interest in the subject matter of the course) and the deep approach.[2] One feature of at least some of the descriptions of these motivations, is that they have emotional connotations. Fear of failure and intrinsic interest are motivational terms with an emotional flavour. The role of emotion in personal understanding will be discussed later, but its occurrence has been recognised for many years (see for example, Leeper, 1963; Young, 1961) and implies that motivation has an adaptational role (Plutchik, 1980). Weiner (1984) sees it as essential to include the full range of emotions in any viable theory of motivation in the classroom. Also, emotion is implicit in some theories of motivation which do not focus on it. For example, Corno and Rohrkemper (1985) mention that intrinsic motivation involves loss of fear of failure. Dweck (1986) takes a social -cognitive approach to motivation in which adaptive motivations are those which promote the establishment, maintenance and attainment of personally valued achievement goals. It is difficult to conceive of personal value without the involvement of emotion. Buck (1984) sees emotion and motivation as 'two sides of the same coin' involved in the activation of behaviour, subjective feelings, and expressive behaviours.

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[2] 2 A third type of motivation is sometimes identified called achievement motivation (eg. Biggs 1984, Entwistle and Ramsden 1983) which can be associated with a third approach to learning called the strategic approach (Entwistle and Ramsden 1983). This does not affect the argument here but further illustrates how outcomes can be layered.

It seems reasonable to assume a role for emotion in the driving of the flow of intention, process, and outcome within personal understanding. Emotion, of some sort or degree, would be consequent on how the context is interpreted and it would lead to the intention adopted. A corollary of this is that active participation (or active avoidance) by the individual in the demands of the context is occurring, otherwise there will be no emotion to drive the flow. But, again we should beware of apparent lack of either positive or negative emotion in a particular context. The individual may be taking steps to avoid these emotions in the context we are examining, and the emotional motivation for this avoidance may derive from a broader context.

This enables us to attempt a provisional listing of the features of personal understanding.

1) Personal understanding is a phenomenon of the psychological time of human beings. Human psychological time derives from the biological, psychological and cultural mechanisms or conditions which give rise to memory, goal-directedness, anticipation and Intentionality in general.

2) Personal understanding involves the adaptational relationships which an individual brings to a new or expanding context. These adaptational relationships have arisen from the relationships with the range of contexts encountered in that individual's life milieu (aspects of Worlds 1 and 3 or the Universal Set). It will be unique for each individual but it is also subject to constraints from the same factors which make it possible in the first place - biological, psychological, and cultural factors.

3) Personal understanding is multilevelled and multifaceted and it relates to a particular context through this and through psychological time. As a result, its adaptational significance may be obscure in the observation of some individuals relative to a narrow context. In such cases, the researcher has to consider how far to expand the context of explanation in an attempt to find the adaptational significance of the observed outcomes for the individual concerned.

4) Personal understanding, since it occurs in psychological time, can be described in terms of a psychological flow. A psychological flow involving past experience or outcome, present sensation and process, and future or anticipated outcomes. Emotion seems to be reasonable candidate for driving this flow, and intention, process and outcome seem suitable concepts for its description. Emotions would arise from interpretation of self in relation to a context, and would lead to the intention being pursued through the processes towards an outcome consistent with the emotion.

Following from these features, personal understanding can be seen to be a concept at the educational level of explanation. It derives some of its meaning from the way it begins to deal with the problems of the multifaceted and multilevelled nature of the relationships between an individual and the range of contexts encountered. It also draws attention to the need to develop consider issues of the flow in time of both individual psychology and context.

Personal understanding and human universals.

The basis for this section has already been covered in chapter 3. Personal understanding has its roots in the constrained plasticity of development and in the representational capacities of the brain. These function to bring about adaptation, in terms of goals and anticipations, of the person to the contexts which have been experienced. The concept of personal understanding can now be extended a little further in this direction.

The forms that personal understanding can take may depend on different forms of communication and representation - mimetic representation and symbolic representation (see, for example, Donald, 1991), or on the possession of bicameral minds or modern consciousness (Jaynes, 1976, 1990), or on particular stages of lifetime development (Egan, 1988). Egan argues that, at different ages, we are dominated by different ways of understanding, which mirror to some extent, the evolution of culture. In this scheme, we pass through *mythic understanding* in which children use fantasy to deal with their daily experiences, to *romantic understanding* which is characterised by wonder at the particularity of the world, to *philosophical understanding* which involves the capacity to search for general patterns or recurrence in phenomena, and finally reach *ironic understanding* which involves some sort of mature integration of all the forms of understanding.[3] However, the development of later means of understanding does not mean that earlier forms are necessarily replaced. They may co-exist. This also applies to the forms of representation which may have evolved at different points in the history of the species.

It seems that most research into understanding is currently primarily concerned with 'philosophical understanding.' However, Egan's scheme, and the arguments by Donald and Jaynes that modern man can at times fall back to earlier forms of

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[3] In his Forward, Egan states his intention to follow this volume with subsequent volumes devoted to each form of understanding. However, these volumes do not appear to be listed in the National Library or the other databases consulted. In this volume he is concerned with 'mythic understanding'

representation or mental functioning, suggest that on occasion we should take a broader view of the types of representation involved in the phenomenon of personal understanding. Egan sees implications for education in his scheme, and indeed, it may suggest that, in the framework offered here, personal understanding is being characterised in too narrow a sense. Personal understanding, perhaps, does not only develop and vary in relation to particular sets of targets, but also in the modes of mental functioning available, or which are chosen to be used. These modes of mental functioning would arise through interactions between the developing person and the context. Figure 11 gives a possible representation of the explanatory area which would be involved. A complete explanation of personal understanding would require that we show how each level of interaction makes the level above a possibility, and also a description of how the higher levels are constrained by those below. It would also require a description of how different modes of representation would develop in the lifespan of the person.

There is much work to do in producing a definitive list of human universals and considering how these universals effect our relationships with the world and the cultures within it (Brown, 1991). A greater knowledge of human universals seems a necessary prerequisite to a fuller understanding of the nature of personal understanding, and would certainly be useful to educational practice. Simon (1990) notes that the invariants found in psychology will not resemble those of physics. As well as being mainly qualitative, psychology invariants

..... *are and will be of the kinds that are appropriate to adaptive systems. Its success must be measured nor by how closely it resembles physics ,but by how well it describes and explains human behaviour.* (page 2)

This section reemphasises the value of a concept of personal understanding in its ability to lead towards the analysis of interactions with current contexts in the lifespan of the person. Additionally, the idea provides a conceptual forum for analysing the roles in educational learning of a broader range of mental functioning than is usually considered to be relevant.

In education, human invariants are relevant to the description and explanation of the complexity of human learning in human contexts. Human consciousness may be one of the the human characteristics or invariants which makes such complex learning possible, and so provides another way of extending the concept of personal understanding.

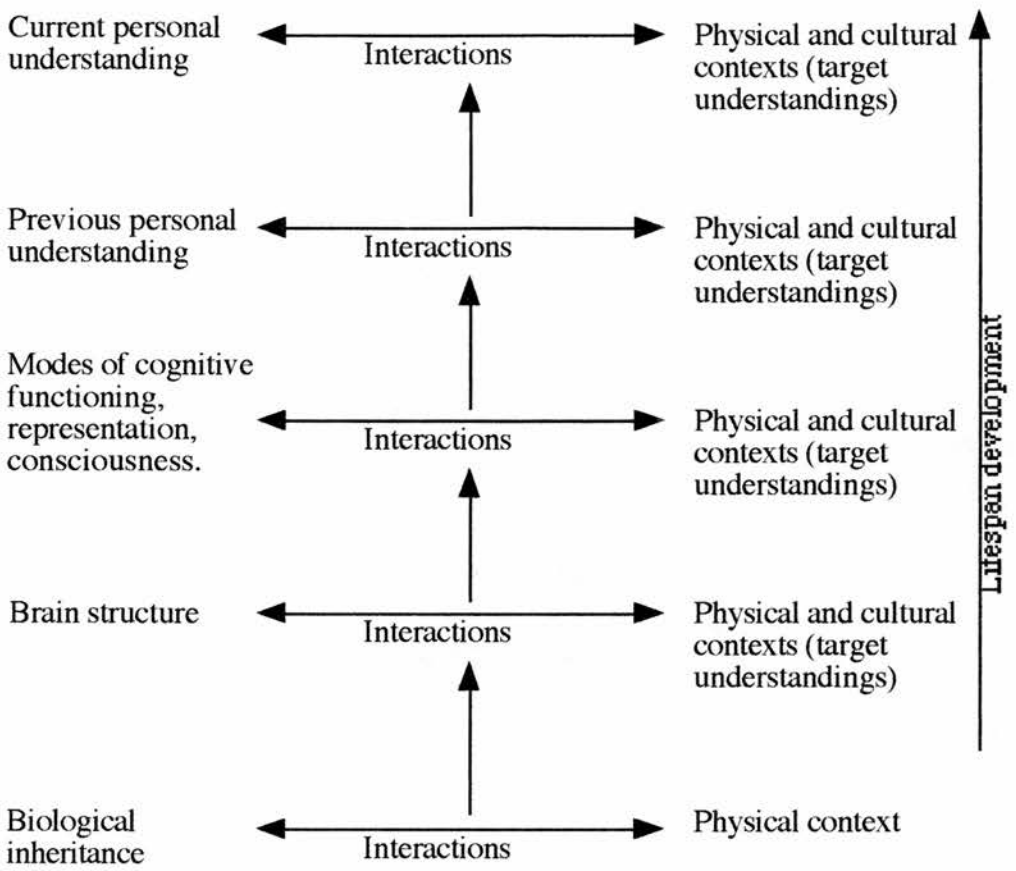

FIGURE 11: AREAS OF INTEREST IN EXPLAINING PERSONAL UNDERSTANDING.

Each level of interactions makes the level above possible and constrains its boundaries.

Personal understanding and consciousness

Consciousness is a notoriously difficult concept to define and to explain. O'Keefe (1985) suggests that many authors emphasise certain aspects of consciousness at the expense of the others which do not fit the theories they are developing. He attempts to outline what a theory of consciousness should explain, and begins by stating that consciousness is both the process of awareness and the contents of that awareness. From reconstructions of what seem to be typical sequences of consciousness, he the deduces that consciousness consists of a stable framework which acts as a setting for a sequence of episodes varying in duration, content and elaborateness. Each episode, even the most brief, has the potential of being part of an extensive story or narrative, either because it can extend an existing narrative, or because it makes a new narrative possible. The entities of which episodes consist, can refer to either the external world or to internal subjectivity.

Although differing vastly in content, and connecting to very different narratives, these episodes are not entirely independent of each other. They are connected by the fact that they are experienced as a succession occurring within the same framework (the same consciousness) and that consciousness has a single proprietor (myself). (Page 64)

From this, O'Keefe derives a list of properties which an adequate theory of consciousness should explain. On the basis of Figure 11, these are also likely to have links with aspects of personal understanding.

1) *The varied, evershifting nature of the contents of consciousness.* Perceptions and subjective states seem to compete for their moment in consciousness. Those which succeed in achieving central stage, acquire a frame which, with continued attention, becomes part of an episode. Those perceptions, subjective states or frames which are not currently on the centre stage, do not necessarily disappear. Instead, they may form a vague and hazy background. However, O'Keefe notes that much cognitive processing can occur without consciousness. Therefore, it is necessary to ask what distinguishes things of which are conscious, from those of which we are not. Perhaps a little vaguely, O'Keefe suggests that we are conscious of those things which can be segmented and considered as individual entities. We are aware of a particular piece of paper, a word, a performance of music: we are not aware of words or music, as abstractions or classes of entities.

However, this does not seem entirely satisfactory. We can imagine discussions in which we do seem to be aware of, for example, music as an entity. We may discuss either why a sequence of sounds counts as music or why it does not. And in that discussion, it would seem that we are aware of some sort of entity which we call

music. The fact that we we do not all agree that something is or is not music, points to two features of consciousness in general, and personal understanding in particular. Firstly, it highlights the individual variation in consciousness and personal understanding which has already been noted. This variation exists between individuals at the same point in time - we have had different musical experiences in our lifetimes, leading to different conceptions of what is music. It also exists between different points in an individual's lifespan - we may, as we grow older, broaden our conceptions of music to include a wider range of types of sound sequences. Secondly, it shows that, in personal understanding, various conceptions may be operating in the background, but they will still be important in constructing the narrative or outcome which is the current focus of attention. This background is therefore part of what has to be explained.

It would seem that it is in the background of personal understanding that 'common ground' (see Chapter 5), or the lack of it, in instructional or other communicational settings, would be found. It is also a possibility that, in forgetting the need to consider the background in our explanations, we assume that some activities occur without representation (and therefore, understanding) necessarily playing an important role (see the discussion of the performance view of understanding in chapter 8). In those activities, depending upon a background of concepts which is presumably represented somehow in the brain, personal understanding, is involved. In other words, personal understanding is involved in virtually everything, if not everything, that we, as conscious beings do. What changes is whether or not the representations or concepts are the focus of personal understanding (as for example, in discussing what counts as music) or whether they serve as a background (as the individual's concept of music does when listening to a particular piece).

2) *The unity, stability, and continuity of consciousness in spite of the constantly varying contents.* O'Keefe notes that, introspectively, one has a sense of an enduring framework which provides a spatial and temporal continuity to the stream of consciousness. This seems similar to the psychological time of experience discussed earlier. O'Keefe identifies three possible sources of this framework. Firstly, the short term stability of the background which may be such things as the intention behind writing an essay, the topic of conversation, the physical world, or the reason why one is in a particular place. Secondly, the ability to knit together a set of experiences in spite of intrusions or gaps, or to relate a current episode to a stored narrative, both of which depend upon memory. Thirdly, the sense that consciousness belongs to oneself.

These three features seem to apply equally to personal understanding as a manifestation of consciousness. A change in personal understanding, relative to a particular context, may involve focusing upon and changing the background by which it is operating, but in many if not most cases, personal understanding will involve adding more detail or episodes to existing narratives or interpretations against a relatively stable background. For example, if the background intention is to cope with the learning task, as in a surface approach to learning, personal understanding will probably proceed by adding more information to a previously rote learned set of facts.

Secondly, personal understanding can return and pick up the threads where it has left off. We can return to studying and analysing an argument in a paper after a break for coffee or to answer the phone. This presumably involves being able to both recall to the foreground the narrative which was being pursued, but also being able to form the same background plan or intention.

Finally, we have a sense that personal understanding is our own, and we may on occasion defend it in the face of opposition from others, or even against strong contrary evidence. There can be an emotional investment in personal understanding which we do not wish to sacrifice (see section 5 below).

O'Keefe sounds a cautionary note. The strong sense of unity of consciousness is no guarantee that consciousness is, in fact, unified. Similarly with personal understanding, we have noted that we may adapt to different contexts in ways which remain unintegrated and inconsistent. However, we do not always experience this inconsistency and only notice it when it is drawn to our attention in some way.

3) *Consciousness is not homogeneous, but consists of a variable foreground and background.* There is little to add to this which was not covered under the other two properties except to note that, at this point, O'Keefe himself introduces the idea that the background can provide a plan or strategic framework by which contents are admitted to, and ordered, within the foreground.

4) *The origin and control of the contents of consciousness* . Items in consciousness have referents to either the external world (perceptions and interpretations of context) or to an internal generator (such as images, emotions, thoughts). O'Keefe points to the need or effort, in many of those cases when a plan is being followed, to keep to it and to avoid the temptation to allow random thoughts, daydreams and emotions to intrude. The background plan is often only dimly perceived, but it can itself become

the focus of attention, for example when there is a conflict of plans. Pani (1996) takes an adaptationist view of representation which seems in line with this. Each conscious representation in thinking is viewed by Pani as being an attempt to generate useful information in moving through a problem space. Also, the production of a new representation is controlled by the current representation of the state of the world (in perception or thinking) and by a hierarchical set of goals.

Personal understanding in educational settings is often under pressure to keep to some sort of plan. When the background plan of the individual does not match the instructional intentions of the teacher, then there is a mismatch between personal understanding of the pupil and the target understanding of the teacher. It is at this point, or in these situations, that education becomes the endeavour to change the student's experiences of the meanings of events and actions (Novak and Gowin, 1984), or to lead students to modify the strategies and knowledge which they bring to the task (Langley and Simon, 1981). Or, put another way, it becomes an attempt to create some common ground.

The idea of control of consciousness creates a link with the literature on metacognition (for example, Flavell, 1979,1981; Nisbet and Shucksmith, 1984, 1986). It also connects to the literature which sees educational learning as being conversations or dialogues between alternative conceptual formulations of the topic being taught (for example, Edwards and Mercer,1987; Entwistle, 1978; Pask 1976a; Thomas and Harri-Augstein, 1985). In this literature, the learner is conceived as having one conceptual formulation of the learning task and the teacher (or textbook, or learning materials) has another. Education is then

A communicative process that consists largely in the growth of shared mental contexts and terms of reference through which the various discourses of education (the various subjects and their associated academic abilities) come to be intelligible to those who use them. (Edwards and Mercer, 1987, pages 62 - 63)

This conception of personal understanding allows us to deal with questions of conceptual change (see for example, Carey, 1991; Vosniadou and Brewer, 1987). Studies which attempt to promote conceptual change (for example Schnotz and Preuß, 1997) can be interpreted as systematically trying to change the background plan or intention by which the student is operating so as to allow them to develop better representations of the task in hand. These, in turn, lead to them create more specific and accurate representations or propositional models of the material being presented.

5) *Consciousness is intimately related to some aspects of long term memory.* O'Keefe suggests that one role of consciousness is in the encoding of episodes and narratives

into long term memory, which involves determining the appropriate form of that storage. Broadly speaking, O'Keefe sees those episodes which have a referent to the external world as being appropriately encoded in a spatio-temporal form, and those in which the material is linguistic being encoded in a narrative form. However, the above discussions of consciousness and personal understanding suggest that, at the level of explanation involving personal understanding, this distinction can blur. The linguistic concepts we develop, for example, what we accept as being music, can affect the way in which we organise our perception of events in the external world, such as a particular sequence of sounds.

6) *Consciousness is involved in some actions and not others.* O'Keefe asks how conscious intentions and conscious learning of skills can be followed by actions which do not seem to involve consciousness. He concludes that the role of consciousness lies in the generation of goals or subgoals and in the calculation of match or mismatch between this and the present situation. When things are happening in a predictable way, and in line with the goals, they proceed without further consciousness of them being necessary. If this is the case, when we ask how this applies to personal understanding, a difficult question arises. To what degree do concepts which we have formed on previous occasions influence our actions and our predictions about future events in current contexts? To put this another way, it has been suggested that personal understanding is a form of adaptation and that, when it seems maladapted to a particular context, we need to expand the context of explanation to look for this adaptivity. The awkward question is:

To what extent has a conscious goal been generated in either the case of the initially narrow context of interest, or the necessarily broader context of explanation, by the individual, so as to lead to a particular way of behaving in a context or as a particular adaption?

It seems unlikely that we always formulate conscious goals to maintain our state of adaptation to our broader life milieu when we are confronted with a new context in that milieu which goes against what we normally value and do. It is only when we come to reflect on the incompatibility of the context, that we either consciously form the intention of ignoring its demands, or of incorporating them into our scheme of things. We then may give reasons for either ignoring them, or for changing our conception of the world and ourselves in some way in order to incorporate them. It seems then that this supports the earlier claim that it is meaningful to talk of personal understanding, even when people fail to adapt to an immediate context in the ways in which it seems to specify they ideally should adapt. The personal understandings, which individuals have developed from encounters in earlier and broader contexts, are acting as backgrounds in taking them in a different direction, and these backgrounds

do not necessarily need to come into the conscious foreground at any point to exert their influence.

In summary, it is through consciousness that we come to interpret ourselves within our physical and social contexts. It is this interpretative framework, which we are calling personal understanding. Depending as it does on conscious foreground and background, the functioning of personal understanding can occur with previously developed concepts and plans operating in the background, which may seem to the observer to be at odds with the requirements of the immediate context. From this perspective, experience of ourselves is ultimately subjective and is like a set of tales which we weave for ourselves.

Weaving such tales about the self and its world is a prime function of consciousness. The reality we experience is a personal one, a subjective construction of the conscious self and its arsenal of verbal skills. Each individual. on the basis of his past experiences, present situation and future plans, and through the use of natural language and its flexibility in analysing and codifying experiences and interrelating experiences systematically, constructs a subjective view of the world and his place in it. (LeDoux, 1985, page 210)

However, we should recall that the adaptive requirements upon our experience of reality, constrain the range of subjective constructions which we can usefully entertain. We can not experience reality in just any way if we are to remain psychologically healthy (see Section 7, below). Also, the study of consciousness requires a historical dimension. Memories from the past and anticipations for the future are as much a part of the field of consciousness as are present sensations. History does not only happen to individuals, but is also caused by them through the plans they develop in line with their anticipations. There is a capacity for expanding one's future (Pankow, 1976).

The above discussion of consciousness and personal understanding suggests that personal understanding, as a concept, can be regarded as deriving from, and covering, the same areas of explanation as, concepts of consciousness, representation and modes of cognitive functioning. However, as an educational concept, it is more specific than these concepts, in that it has to be discussed in terms of particular contexts which the individual has encountered, and the actual goals or intentions (whether background or foreground) which are being followed. As such, the value of the concept of personal understanding in this area lies in it being an integrative concept which which brings together such concepts as thinking, learning, motivation and personality. These concepts appear in the next two questions regarding personal understanding.

Personal understanding and consistency of the person.

Again, this is a complex and difficult area which also overlaps other issues. Here, the aim is to point to the general issues involved, and how the concept of personal understanding relates to these issues.

Essentially, the question is, 'How can we refer to a relatively stable entity such as a person, while simultaneously pointing to the changeability of that entity through both time and contexts?' How is it possible for individuals to remain constant within a framework of behavioural characteristics which are themselves inevitably changing (Clarke and Clarke, 1984)? Oyama (1993) contrasts a focus on change with a focus constancy, where there is

...constancy of a character through time, in spite of turnover in constituent materials and shifting conditions, similarities among related individuals or members of a species, continuity across generations or among related species. (page 19)

Implicit in the above formulations is the notion that there is some entity which can remain either constant or can change, which is separated by some sort of boundary from other entities. Biologically, these entities would be the organism and the environment. Psychologically and educationally, they would be the person (individual) and context.[4] Given the earlier argument for maintaining continuity across levels of explanation, we need a view of personal understanding which allows for both constancy and change.

Traditionally in biology, an organism is seen as being that which mediates between genes and the environment. The organism is made up of a range of phenotypes - the features by which we recognise an organism. These features range through the specific molecular and cellular processes that take place within the organism to more global physical features and behaviours. The phenotype is the result of contributions from both the genotype of the organism (the actual genetic material which is found in the organism) and the environment. Environmental alterations of the phenotype do not affect the genotype.

The environment, therefore, provides the arena in which the genotype acts; and accordingly, the phenotype represents the ultimate expression of the interaction of the genotype and its environment. (Levine,1972, page 5)

This formulation of the concept of organism still seems to be dominant in biological

[4] Theories can be classified according to the way in which they perceive these entities interacting (for example, Snow, 1994).

textbooks. It suggests that one source of constancy would be the genetic material we possess. However, the concept of organism has been expanded more recently. Gould (1980) argues that an organism is best seen as being a whole system of historically constrained relationships that drastically limit the possibilities for evolutionary change. Constancy in this case would therefore presumably be a function of the limits for change. Wicken (1987) expands further on this by noting that organisms themselves pose constraints and limitations on their own evolutionary destiny, and goes on to develop a concept of organism from a 'thermodynamic ecological viewpoint.' In this view, living things emerge as both processes and things. They have structures separated from the environment by distinct spatial boundaries, but those structures are in a state of flux, while still being maintained by the imposition of rules of form on transformation of matter and energy. Thermodynamic flows secure the structure, but conversely, the structure informs the flow. The structure contains constraints which have been built into it for functional reasons. Constancy in this case seems to emerge as being the historical result of a developing structure with inbuilt constraints on its future development - constraints which have arisen in line with the functions of that structure or aspects of it.

The above concepts were developed to explain constancy and change within the time scale of the evolution of species. However, they also seem applicable to the problem of constancy and change in the psychological time of human individuals, since they apply to the view of an organism as being a hierarchically organised system of constraining relationships. Human psychology involves many complex and domain-specific mechanisms, each suited to serve a particular function (Buss, 1991; Karmiloff-Smith, 1993). Human nature comprises the species-typical solutions that humans have evolved in response to the selective pressures faced in ancestral conditions. An essential part of the description of these, according to Buss, is the goal directed behavioural strategies which have evolved. Although very diverse, there is probably some sort of deep structure underlying these goal directed behaviours. The environment experienced by the organism is itself a product of evolution.

The consistency debate is clarified by distinguishing between evolved psychological mechanisms and manifest behaviour. Consistency will be found at the level of psychological mechanism and the environmental inputs that predictably activate them; specificity of behaviour will be found in the adaptational problems that humans confront across different situations and in the context-dependent strategic solutions that they deploy to solve them. (Buss, 1991, page 485)

The idea of flow in personal understanding has been introduced, and this seems consistent both with Wicken's formulation of structure and flow, and with Buss's evolutionary account of human nature. Consistency of the person in personal

understanding would derive from the background to consciousness which individuals developed through adapting to the contexts of their life milieu. This background would have structural properties in so far as it is made up of concepts, modes of cognitive functioning, and goals or intentions. These structural properties make it possible to change aspects of itself, but also constrain the degree of change to that structure. This consistency of the person in personal understanding would then be a function of memory and of the consciousness which give rise to this structure. An inevitable consequence of consciousness is a sense of self (Jaynes, 1990), which goes beyond a mere identity or name, in that it is

...the consciously constructed although variable, fragile, and defensive self that shakily pilots us through the alternatives of living consciously. (page 458)

Jaynes notes that the advantage of such a sense of self is that it tells us what we can, and what we should, do. As such it will enable us to interpret situations which we saw as being the key to explaining personal understanding. Gazzaniga (1992) specifically argues for an interpreter which has evolved as a functional unit in the human brain and allows thought about the implications of our own and others' actions, so that a social context can be grasped in terms of its meaning for personal survival. Recent research in neuroscience, seems to make this position more plausible (see Beardsley, 1997). This ability to interpret the contexts in which we find ourselves, arises from the mechanisms underpinning the way we think, the way we are motivated, the way our senses and perceptual systems operate, the way we remember our pasts, and so on. In so far as these are mechanisms within the person, they will play a role in the consistency of the person - a consistency which both observer and observed feel, despite the range of contexts that the observed person may encounter and the variations in adaptation that person makes to them. The following quotation suggests the field we might expect to be covered by personal understanding.

A person's cognitive system, which includes one's memory system, can then be seen as a unique blending of cognitive processes with genetic, personality, affective, ability and cultural factors. Cognitive scientists have also delineated other factors (eg. one's stage of development) which must be included in this blending process.

...Perhaps, then the concept of "identity" can be best described as the unique internal cognitive properties that each individual brings into his or her relationship with the environment. (Schlechter and Robinson, 1988, pages 313-314)

In order to give this more relevance at the educational level of explanation, we can substitute 'personal understanding' for 'identity' in the above quotation. In this way, we include not only the cognitive properties of the individual, but also interpretations

of context, goals and anticipations. Ultimately, the unity of the person lies in the functioning of the brain in the whole life-system of the person. It is in the unity of the brain as a system, that the subjective sense of unity in mind and personality lies (Young, 1986). It is important to consider

... the whole life of each individual, his capabilities, wants and needs. His knowledge and capacity for reasoning are part of the whole program for living. (Young, 1986, page 172)

However, it seems worth noting that there may be features of personal understanding and its background which once developed, contribute more obviously to a consistency in the way in which personal understanding occurs, if not to the final results or outcomes of it. At educational levels of explanation, these might include serialist, holistic and versatile styles of learning (Pask, 1976b), and motivational styles (Kozéki, 1985), as we shall see in the next section. But it seems that personal understanding as a concept of explanation is meaningful within the general problem field of consistency and change of individual and personality, and has, therefore, explanatory value in this context. As with concepts of adaptation of organisms in evolutionary theory, it is possible to consider personal understanding as an adaptational concept which allows for both consistency in time and also constrained change and variability. It does, however, also bring together other psychological and educational concepts in a way which is consistent with other levels of explanation, which leads us to the 'trilogy of mind.'

Personal Understanding and 'the trilogy of mind'

How does personal understanding relate to cognition, motivation and emotion? It has already been suggested that personal understanding can be thought of as being a flow of intention, process and outcome which occurs through psychological time and is possibly driven by emotion. However, it was noted that these concepts mark our attempt to describe human experience for explanatory purposes, and that human experience is really continuous through the psychological time of past, present, and future. The terms, 'intention, process and outcome', were derived from research which had an educational orientation, and not from mainstream psychological literature. In line with the argument of this thesis, however, further clarification of these terms requires to be in line with psychological theorising, particularly theorising which can be said to be in terms of a psychology of personal meaning.

Let us take 'outcome' first. Two aspects of outcome seem relevant - representation

and sensation. Representation, like other concepts we have encountered, has various meanings or applications. It can be used to refer to the genetic material that the organism possesses, as being a representation of the environment, or to brain programmes as being representations of the world, or to various levels of abstract representations such as different forms of artistic presentations (Young, 1986). Generally for psychology, the problem of representation is, 'what do we think in' (Russell, 1984)? They are the workspace of thinking and understanding (Halford, 1993).

There is considerable dispute about how representation in the brain comes about. Does it involve the manipulation of symbols in the mind according to a formal set of rules possessed by that mind (Fodor, 1975)? Alternatively, does the brain represent without computational rules as in connectionist models (Bechtel and Abrahamsen, 1991)? Or should we use both types of explanatory models of representation together, according to their own strengths,(Bechtel and Abrahamsen, 1991)?[5]

Halford (1993) cites an argument that, in a sense, the code of representation does not matter to theories of cognitive functioning. At this level, we are most interested in the structure of representation, rather than its code. What determines the structure of that representation and makes it more or less equivalent to other forms of representation is the information which it contains. However, Halford also notes that, although it may not affect our logical analysis of representation, the form of a representation can have important implications for the psychological processes which can operate on it. For example, what resources are needed to maintain the representation? Do linguistic representations and representations utilising visual imagery require different resources? However, given the general agreement that it is through representation that we relate to the world, we need some sort of conceptual handle on it. This view is compatible with insights into human understanding and is also psychologically and biologically plausible, while leaving the actual code of representation for others to determine. Changeux and Dehaene (1993) argue for a view of multiple levels of biological organisation which seems compatible with the arguments of this thesis and suggests that:

Mental representations are not static states of the brain, but are produced and chained

[5] Bereiter (1990a) argues ironically that connectionist models may help us to think more clearly about rules - the rules of instruction as well as mental representation. Rules may only become comprehensible, and therefore only meaningfully cognitively represented, after a student has acquired the competence the rules represent or specify. However, Norris (1991) is more cautious. Connectionist models are not yet - despite wishful thinking - intelligent problem solvers. Only when we understand the structure of complex tasks can we then build interesting connectionist models. Connectionist models will not furnish that understanding for us.

within a system in constant dynamic interaction with the outside world and within itself. They are part of a system in constant evolution within psychological time scales. (page 382. Original emphasis)

The degree to which a particular representation has apparent permanence depends upon its adaptive significance in this system. This argument supports the idea of the flow of personal understanding, but it also leads to questions of how we should view memory. Janowsky (1993) utilises a model of memory (Figure 12) encompassing various forms of adult learning. A biological basis can be assigned to at least some of those forms of learning and memory. The model is one of memory having multiple forms with multiple biological bases in order to accomplish the full range of mnemonic tasks. Memory is divided into two broad classes on the basis of the following criteria.

Nondeclarative memory includes learning that cannot be brought to conscious recollection. By this, Janowsky means that we cannot bring its contents to mind and think about them.. Nondeclarative memory includes skill learning, priming (preference for certain stimuli on the basis of previous stimuli), simple conditioning and habituation. These forms of learning may be very short lasting (as in some cases of priming) or very permanent as for many skills (the continued ability to ride a bicycle after a long gap). In some forms of nondeclarative memory, the learning results from repeated exposure to a stimulus as in habituation or classical conditioning. Finally, the representations are relatively inflexible. For example, expertise in one motor skill does not necessarily result in faster learning of another.

In contrast, declarative memory representations are accessible to consciousness and do not need repeated experiences to be formed. Although repeated exposure may strengthen a representation, each exposure can maintain its own distinctive 'spatial and temporal tag'. For example, Janowsky suggests that we may build up our knowledge of a colleague over repeated conversations with the person. However, each conversation will have its own representation. A representation which is likely to include information about the context (for, example, the time and place) as well as the content of the conversation.

The context of the information is recalled with the information itself. Therefore, each fact or event is temporally distinguished from any other time it was experienced. Finally, the knowledge in declarative memory is flexible and can be used in domains outside the original learning situation (eg., facts learned in school can be flexibly applied outside the original learning domain. (Janowsky, 1993, page 667)

From this description, it would seem that the conscious focus in personal understanding derives from our ability to form these sorts of declarative memories,

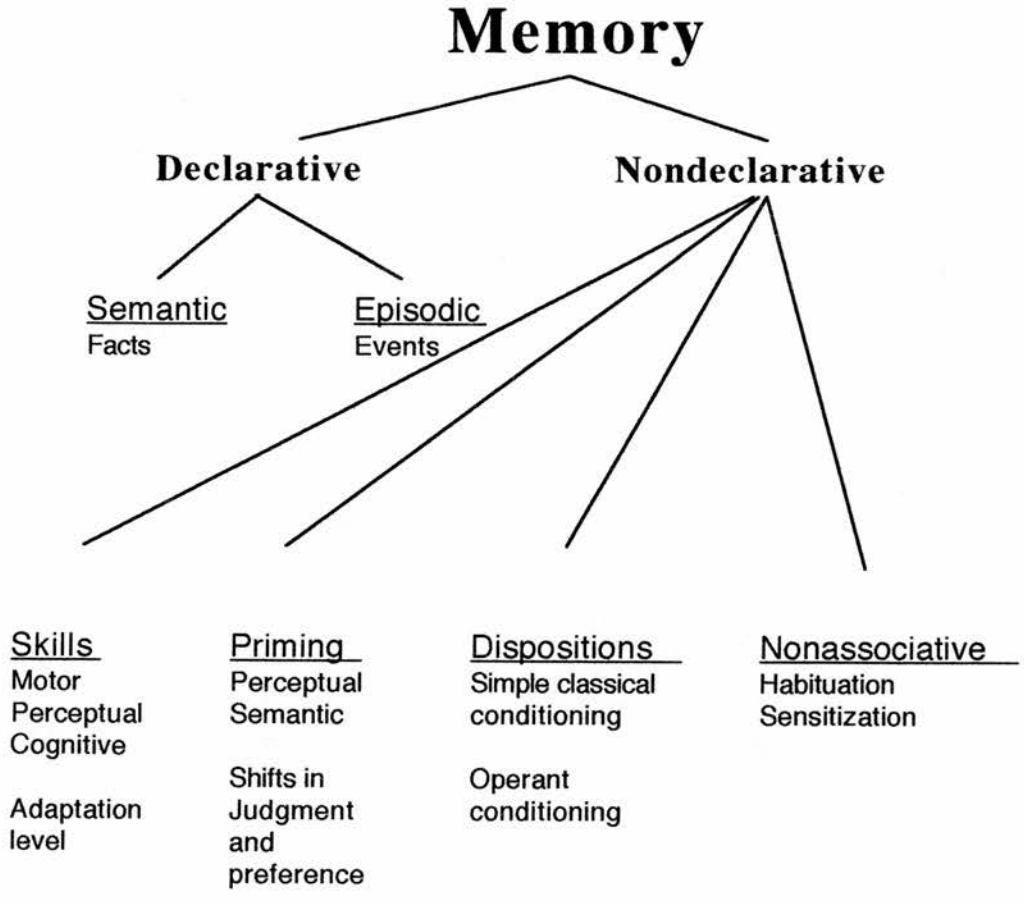

FIGURE 12: A model of memory. From Janowsky, 1993, page 666

and that its flow in psychological time derives from these memories. However, a possible role for nondeclarative memories should not be lost sight of. They are, in some cases if not all, likely to be part of the background in personal understanding. For example, the motor, perceptual and cognitive skills which we have represented in nondeclarative memory must play a role in the way in which we think about and manipulate information in consciousness. Also, although the contents and processes of nondeclarative memory are not open to conscious scrutiny, their results are (Cohen,1989). We can become aware that we have become habituated to a stimulus - someone tells us that we do not react. We can be shown that the skill which we are applying is limited and how to improve it. The incident involving the realisation of how to improve a skill would presumably be stored in declarative memory, but the improvement, once learned, would presumably also involve some change to the representation of that skill in nondeclarative memory.

Also, this perspective helps us to keep something else in mind, which often seems forgotten when discussing skills which do not need any conscious attention for their performance. There is a sense that the skill has had a purpose to it which must also be part of its representation. For example, the skill of riding a bicycle must have a representation of what a bicycle is and what it is for. It is difficult to see anyone learning to ride a bicycle, unless they have some sense of its purpose as a two wheeled vehicle which would carry you from A to B. Conceptions of purpose would develop on encounters with the object concerned (that is events involving a bicycle) and may develop over a range of such encounters - for racing as well as mere transport, to carry other objects. As such they would be part of declarative memory. However, how many of us can remember our first encounters with these ideas of the purposes of bicycle? They very quickly become tied up with the skill of riding itself, through the way we approach the development of that skill, and so become difficult to recall from declarative memory. It is perhaps the integral representation of purpose and skill in nondeclarative memories of this type, which (at times, at least) makes transfer difficult for us.

One feature of Janowsky's model is that it brings out the problem of relationships between verbal and non-verbal thought. The above discussion suggests that both types of thought may have a role in non-declarative memory. That they may also both have a role in declarative memory seems clear from its definition in the model and the possibility of recalling events along with accompanying sensations or emotions. Hebb (1980) argues that both types of thought are involved in high level thinking. We have ideas which we struggle to put into words. A poet has a vague notion of a poem coming on before commencing upon writing it.

So nonverbal thought may exist at a high level, even with reference to an ultimately verbal performance. But anyone who writes knows that having to put one's ideas in words can sharpen thought., and even on occasion lead to the discovery of error, and it seems obvious that the talking to oneself that goes on in any difficult task is not mere accompaniment but overflow from the active part of the thought. Language is the outstanding distinctive mark of human behaviour, and this, it seems may be true of thought also. (Hebb, 1980, page 117)

In education, we tend to perceive the importance of language as being the prime means of delivering education, and as being the prime means of thought and behaviour in educational contexts. What we should not forget is the possibility that non-verbal thought is also going on at a high level in such language bound contexts as classrooms and other educational institutions, and that part of the explanation of outcomes may lie with this, as much as with language based thought, behaviour and activities. Non-verbal thought may be part of the background to consciousness and personal understanding, and as such, have a role in the intentional framework of behaviour.

Clearly, this is a very complex area. One at the centre of cognitive psychology and which will continue to exercise many minds for some time yet. However, what this analysis seems to suggest is that representations, both verbal and non-verbal, are inevitably involved in some sense, and in some way, in what we do. Representations are more than just a record. They suggest ways of acting when a given situation occurs in the future (Young, 1986). Personal understanding involves both declarative and nondeclarative memories in various sorts and degrees of complex interactions of verbal and non-verbal thought. One task for a theory of personal understanding would be to investigate more thoroughly the working of declarative and nondeclarative memories in the lifetime adaptations of the person to life milieu. A promising start may be Karmiloff-Smith's (1993) concept of *representational redescription.* Redescription involves rerepresenting in a different format within the mind, information already present in its representations. This model of cognitive change postulates that the mind stores multiple redescriptions of knowledge at different levels and in different types of representational format, which are increasingly explicit and accessible. Such a view could be used to underpin explanations of the evidence that children and adults gain increasing control of their memory processes by becoming more aware of the intellectual demands of memory processes and by developing or acquiring skills and strategies to deal with these demands: that is, in the development of metamemory (see for example, Kail, 1990).

The above issues seem to parallel those of expertise (see for example, Chi et al, 1981; Glaser and Chi, 1988; Glaser and Bassok, 1989). As one progresses from novice to expert, knowledge acquisition seems to proceed from

...declarative or propositional form to a compiled, procedural, condition -action form. (Glaser and Bassok, 1989, page 635)

Knowledge for an expert is bound to conditions of applicability and to conceptions of the goal structure of a problem space. Experts can chunk items in memory so that they have effective sequences for action. Experts are also fast at solving problems. It can be said that their personal understanding is well adapted to the types of problems in which they are considered to be experts. However, there is little evidence of transfer of expertise from one domain to another (Glaser and Chi, 1988), just as with procedural memories. However, expertise in a domain may be an essential prerequisite for insight in solving new problems in a creative way (Ippolito and Tweney, 1995).

However, we must also beware the notion that human activities are possible without understanding. Halford (1993) suggests that activities such as word processing and car driving can be learnt without understanding. That is, we do not understand how they work, but we can all still use these machines with varying degrees of skill. What is being suggested in this thesis is that understanding <u>is</u> involved in learning these skills. There is a conception of the purpose of these machines which makes their use possible. This is not only an conception of the purpose of the whole machine (to get from A to B, for creating and writing of various types of documents), but also of the purposes of the component parts (the steering wheel, the pedals, the keyboard, the disc drive and so on).What we may not know, and do not necessarily need to know, is the detailed mechanisms involved by which these artifacts serve their purposes. We can all understand the purpose of these items and so we can all begin to use them. In fact, conceiving of the purpose of some forms of target for understanding may be an essential prerequisite for personal understanding to form relations with them - for example, to man made artifacts and entities such as theories, stories and works of art (See also, Perkins, 1986, 1987).

There is, perhaps, a tendency to assume that, if an act is something we can all do then understanding is not really involved. Understanding has to involve some degree of conceptual difficulty for the individual, or it is not really understanding. However, we take personal understanding to be more general than this - how human beings relate to the world, and the forms of representation humans use permeate throughout all our activities in the world. There are certain activities in which we are all expert - at least in so far as we have a recognition of their purposes. That is, there are some contexts in which personal understanding relates to the world by discerning a purpose behind what it is attending to. That discerned purpose, in some cases, may be a more important part of the representation than any representation of how the object works.

Sensation was the second aspect of outcome in personal understanding. As we engage in the world we have feelings of difficulty in making sense of the context or information in it, of frustration, satisfaction, fear, pleasure, joy, excitement, and so on. That these sorts of emotional sensation have some sort of basis in the cortical and limbic systems of the brain seems evident (eg. Kalin, 1993; Lazarus, 1991; Young, 1986). It has been suggested that they underpin all our behaviours, from the most basic to the most sophisticated forms of intellectual and aesthetic appreciation (Young, 1986). The neural systems involved in emotion have a strong association with those involved in memory, and this is seen by some as being the basis for the intimate linking of emotion and memory themselves (Richards, 1987). These neural systems are also identified as the source of 'value' which governs the adaptation of behaviour to context (Edelman, 1989,1992; Young, 1986).

Richards (1987) cites convincing evidence that the human limbic system went through as much evolutionary change as did the cortex in the move to bipedalism, and that evolution of the limbic system may even have preceded evolution leading to the expansion of the cortex. The changes in the limbic system relate to the requirements for social and behavioural adaptation arising from such factors as sexual behaviour, social organisation and feeding. In general, the human limbic system is relatively larger than in most other primates and correlations between types of primate social organisation and number of neurons in parts of the limbic system can be observed. Certainly, there are well established pathways between the limbic areas and those of the areas of the cortex associated with both planned and motor behaviours (Kalin, 1993; Richards, 1993; Young, 1986) and which can underpin obsessive as well as normal behaviours (Gazzaniga, 1992).

The intimate relations between the systems of emotion and cognition seem to be the basis for theories stressing the need to place emotion in cognitive and/or social contexts (for example, Harre *et al*, 1985; Lazarus, 1991, Parkinson, 1995), and a consequent debate as to where causal primacy should be placed. Lazarus (1991) and Gazzaniga (1992) both note that we can only see correlations between the biological processes and cognitive processes involved in specific behaviours such as obsessive behaviours, not causal direction. However, there is a tendency to assume that a single explanatory framework can underpin cognition and emotion.

If emotional states arise from mechanisms required for coping intelligently in a complex and rapidly changing world, this challenges the common separation of emotion and cognition. (Sloman, 1990, page 232)

This is more consistent with organismic principles relating to adaptation (Lazarus, 1991). Parkinson (1995) notes that the idea of emotion serves purposes for both

scientific and everyday uses, but

it is important to see the everyday idea of emotion as part of the phenomenon in which we are interested rather than as a separable categorisation of an independent psychological reality. (page 7)

Sensations, or emotions, as the outcome aspect of personal understanding seem, in this view, to form part of the representation. As such, they will form the basis for the flow in personal understanding by acting, in part at least, as the motivational basis behind the intention being pursued. Feelings of mastery, satisfaction, and so on in a context will form part of the representation through which the context is interpreted and be instrumental in making it more likely that the intentions associated with mastery would be pursued in similarly interpreted contexts. Emotion, therefore, also is intimately linked with motivation. Gallistel (1985) argues that humans have the ability to represent their emotional states as experienced emotion and that this enables them to direct their behaviour in terms of these emotions. The emotional flavour of motivational concepts in education has already been noted.

Authors also point to a role for learning in the development of motivation and emotion (for example, Buck, 1984; Epstein, 1980; Lazarus, 1991; Richmond, 1995). This learning can be involved in finding ways to achieve motivational and emotional ends (Epstein, 1980), the significance of emotion in communicative acts (Buck, 1984; Richmond, 1995), or the development between childhood and adulthood of more complex forms of learning or meaning making (Lazarus, 1991). In the latter case, adults or more mature children can be seen to develop cognitive processes which are more complex, abstract and symbolic than those of the younger child. Lazarus notes two possible errors.

One of the problems in thinking about personality and emotional development has been the tendency to use the simplest level of explanation to account for the most complex and abstract levels of functioning, as when conditioning becomes the explanation of all learning. In the very young child, who has little or no self-awareness and limited cognitive resources, the learning process is apt to be relatively simple and automatic, whereas in a more mature child or adult, more advanced kinds of learning are apt to be involved.

The problem takes the reverse form when the focus is on adults instead of young children. We tend, erroneously I think, to assume that adults will use only the most complex and advanced forms of thought rather than childish ones. (Lazarus, 1991, page 339)

The possibility that the discussion of understanding tends to be too narrow in educational contexts has already been noted in the earlier discussion of human universals. Forms of cognitive functioning or representation, which may be available

at different ages or as throwbacks to earlier times in our history as a species, may be differentially used in particular contexts. The way the need to use these resources is perceived by the individual, will be influenced or motivated in some way by the past history of the individual and, if the above argument is correct, will involve emotion.

A concept of personal understanding requires to be flexible enough to allow for individuals to use some or all of the resources available to them, and in various ways. Although it may well need expanding and refining in line with this possibility, and as applied to other educational contexts, the concept of forms of understanding (Entwistle and Entwistle, 1991a, 1991b) seems a useful point to begin to explore how the concept of personal understanding can be developed, researched, and expanded into a theory of individual development in educational contexts. Let us try to construct a scenario of how personal understanding may function in educational contexts to produce one of the forms of understanding - that of an individual conception of the discipline which is at the more complex end of the above hierarchy of categories. It may also satisfy Richmond's criticisms of theories such as Lazarus (1991) for not placing sufficient emphasis on the interpersonal nature of emotions.

A useful point to begin is Kozéki's (Entwistle and Kozéki, 1988; Kozéki, 1985) theory of motivation in education. This is a theory which conceives of motivation as developing out of the learner's experience. Three domains of motive are identified: the affective, the cognitive and the moral domains. The behaviours of others who are significant in the life of the child, act as reinforcers in these domains so that each domain has three motives (Table 2).

In the early stages, the child is likely to establish, through the approval of parents, teachers and peers, the rewards of warmth (loving caring sentiments), identification (one sure way of ensuring the approval of others), and sociability (acceptance by friends). Subsequently, and in parallel, reinforcement in the cognitive domain will come through independence (achieving something in one's own way), competence (extension of cognitive and practical skills), and interest (self expression).

Finally, in the moral domain, the child derives rewards from personal and social responsiveness. This domain describes the attempts to integrate and control the various sources of pleasure and pain, to reach personal decisions concerning right and wrong actions, or what will be rewarding or punishing in terms of both personal and social values. Self-esteem develops from living up to the trust of others and becomes

Domain	Associated motives
Affective	Identification Sociability Warmth
Cognitive	Competence Interest Independence
Moral	Self esteem and trust Responsibility Compliance

Table 2: Domains of motivation and motives in Kozéki's theory of motives and motivational styles in education.

internalised in conscience. Compliance reflects the controlling influence of factors such as social norms, and higher order moral values, the acceptance of which can be satisfying. Finally, responsibility is the reinforcement derived from judging one's behaviour in terms of internalised standards of what is acceptable.

As they develop, children display some selectivity as to what they find rewarding. This selectivity arises from a combination of experience and basic temperament. For example, some may find parental and teacher approval most rewarding. Others may be most rewarded by mastery. Others by living up to the standards of society. Out of this developing preference, the individual develops a motivational style. There are a range of these, but Kozéki sees the following as being most distinct.

1) Dependent Style - involving a pairing of the affective and moral domains.

2) Independent style - involving a pairing of the cognitive and affective domains.

3) Dependable style - involving the paring of the cognitive and moral domains.

These styles develop from a linking of

... *the strivings and actions of children on the one hand and their consequences on the other.* (Kozéki, 1985, page 192)

As the child matures, motives become more consciously recognised as intentions, since their actions lead to feelings of satisfaction and a strengthening of self-esteem. In terms of the earlier discussion, each style has emotional consequences for the individual. In this case, the positive emotions associated with satisfaction and self-esteem.

This theory seems to have at least three strengths which are worth noting. Firstly, it is compatible with other theories of thinking and learning styles (for example, Sternberg, 1994) [6]. Sternberg identifies three different styles - the legislative, executive and judicial. The legislative person likes to come up with new ideas, new ways of doing things, and is a person who sets and follows personally derived goals. An executive person is someone who prefers to work within externally set goals. Direction for the individual derives from goals which are set by others. Judicial people tend to be critical and are constantly evaluating the people and things which they encounter. This

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[6] Thinking and learning style here does not refer to mode of processing, as with reference to Pask (1976b), but to the way in which people control their thinking.

theory seems a little simplistic compared to Kozéki's.

Although the latter theory also posits three main styles which direct how the person operates, Kozéki's seems more flexible in description than does Sternberg's. For example, Sternberg sees himself as being legislative, and this suits his position as an academic since he is paid to generate ideas and experiments. However, it seems artificial to separate this function from that of critically evaluating the ideas of himself and others, since Sternberg also does the latter in the same paper. It would seem also to be part of both his thinking style and function as an academic. Kozéki's description of a dependable style seems more appropriate, combining cognitive motives with moral. In the latter case, people such as Sternberg seem to have internalised cognitive goals, including independence, with moral goals showing a particular kind of compliance with the externally set goals of the academic institution within which he works.

The second strength of Kozéki's theory is that it encompasses the various distinctions between intrinsic and extrinsic motivation (see, for example, Bong, 1996), but gives a wider insight into the possible range or varieties which may exist under each heading. It also shows how rewards which are normally regarded as being extrinsic may in fact be providing internal rewards which are adaptational within the life milieu of the person. For example, seeking the approval of others is an extrinsic motivation, but the individual may develop internal reward states associated with obtaining that approval. It is then possible intentionally to seek to attain those internal reward states.

The final strength is found in noting, that although students may exhibit a motivational style, they are not regarded by Kozéki as being completely fixed by adulthood. They are open to change, especially through educational intervention. The balance of motives may change gradually with experience, although motivational styles are relatively stable by adolescence. This is again consistent with an adaptational viewpoint in which consistency and change of the person can be accounted for.

Which type of motivational style could give rise to an intention to develop one's own conception of the discipline and what form could the reinforcing motives take? Although Kozéki's terminology may seem out of place in this context, the best candidate for a motivational style seems to be the dependable style, combining the motives of competence, interest and independence, with motives of self-esteem, responsibility and compliance. In this style, it would be possible for individuals to master a discipline cognitively, in line with their own feelings of competence, interest, independence, self esteem and responsibility. Responsibility in this case would be

consistent with some internalised measure of what is acceptable, rather than upon an externally set criteria..

Forms of understanding have breadth and depth but also a structure which varies in both breadth and depth (Entwistle and Entwistle, 1991a, 1991b) - a potentially recognisable and reviewable form which can become a knowledge object (Entwistle and Marton, 1994). Once formed, the knowledge object often exhibits a certain degree of independence from the assessment requirements and structure of the course, depending on the intention of the individual.

The idea that understanding (personal understanding in the terminology of the thesis) attempts to perceive some underlying order in the target it derives from the chaotic world of experience is not particularly new. For example, Goldstein and Goldstein (1978) analyse a number of examples ranging from Helen Keller's autobiography, through Kekulé's description of his discovery of the benzene ring , through Kepler's account of his discovery of the laws of planetary motion, through the accounts collected by James (1901) of religious experience, and on to the poetry of Keats, in an attempt to illustrate the imposition of order by the persons concerned. In all these cases, the authors note that the person could be said to have gained understanding because they feel they have imposed order. To translate the terminology again, the target understanding in this case has a lack of clarity of structure, and personal understanding has adapted by feeling for, and finding, its own structure and sense of meaning which it can impose upon the target. It is not in this case an adaptation to an already complete structure which has occurred. In these cases, it is as if feelings have guided the efforts to understand.

Feeling seems as it were to grope ahead of perception and to put out cognitive tentacles in advance of clear apprehension. (Osborne,1963, page 137)

Goldstein and Goldstein (1978) note that, although they are very real, it is difficult to distinguish the subjective feelings that accompany the establishment of order in the range of cases they describe. Perhaps this is because, in reality, they have a common basis? There seems to be a sense of the person having created a structured form of representation which is adaptive in solving a problem, or problems, within the life of the person concerned. The feeling which gropes ahead may be a feeling of working towards or seeking a form which has aesthetic properties from the perspective of the person involved. The following description illustrates this possibility.

Eisner (1985) argues that all things which are in any sense made possess form. That is, form is possessed by such things as products of art, scientific theories, hypotheses

or practical objects. A form which is well constructed in line with its purpose has aesthetic properties which can be appreciated by the person creating or contemplating that form. Frijda (1989) distinguishes two types of aesthetic emotion. Firstly, are the complementary emotions when we feel some sort of sympathy or identification with the object, for example, when we cry at the fate of a character in a play. Secondly, there are responding emotions, for example, crying because we have witnessed a perfect form, a perfect realisation of an idea. We seem to be mainly concerned with the latter here, although perhaps not as extreme instances.

Some authors (see for example, Humphrey, 1984; Ziff, 1981) have attempted to identify an evolutionary basis for the capacity to appreciate aesthetic properties. Ziff sees the achievement of an aesthetic form as a means of bringing together experiences in a way which lightens cognitive load in the handling of complex information during periods of concentrated attention. Humphrey argues that the feelings or emotions associated with the capacity for aesthetic appreciation are internal rewards for mental activity which is adaptive. These feelings are motivational since they cause us to search for similar experiences (see, also, Young (1986). Brown (1991) suggests that it is a human universal to be driven to organise unexplained stimuli into a coherent cognitive matrix and that this may be the basis of an aesthetic sense in which we appreciate skill in doing this. In common with other human capacities, the aesthetic sense can be argued to play a role in its own development.

Once fresh structures have been achieved, new modes of looking may also evolve, themselves evoking pleasure for the way in which awareness is reached and extended (Osbourne, 1984, page 137.)

This idea is consistent with the earlier arguments about psychological time, flow and about representation. Eisner also seems to suggest that form plays a role in its own development as he argues that form is not only an attribute or condition of things, but it is also a process through which things are made. Individuals, through their biographies of experience, become able to experience aesthetic properties. These aesthetic properties are motivating since they provide a source of stimulation resulting in internal satisfaction for the individual. This internal sense of satisfaction arises both from knowing the world in the way to which the aesthetic points and from the aesthetic in its own right. Through the aesthetic, order is conferred onto the world. An aesthetic order in which the world 'fits', 'feels right', 'is in balance', or 'within which harmony is created'. We can now provide a suggestion as to how an intention to develop one's own conception of a discipline could develop which seems in line with Kozéki's theory and these suggestions about form and aesthetic appreciation.

1) From early childhood, we begin to experience forms. The forms we experience, or learn to experience, will be those to which we are formally and informally introduced.

2) Experience of these forms in suitable contexts leads us to be able to perceive their aesthetic properties. Suitable contexts would be those in which interactions with others lead us to see the relationship between form and purpose in certain ways. Also, these interactions may encourage us to create our own forms rather than to simply appreciate those created by others. Alternatively, the context of interactions with others may suggest to us when there are appropriate well integrated forms to be appreciated and when we should create our own. In some cases, we may see a form but not appreciate its aesthetic properties because it does not have any impact on how we feel about the world. The aesthetic properties of the form do not connect with the way in which our aesthetic capacities have developed. Its adaptational significance does not lie in its aesthetic properties in this sense, but perhaps in line with some other emotionally based motivation, for example, a desire to master the form of a course presentation in order to avoid failure.

3) The experience of the aesthetic has its own 'built in' stimulation as it confers personal meaning by allowing one to feel, in some sense, 'at home in the world'. The perception of aesthetic properties gives one positive feelings of the highest order. A mastery of form without the aesthetic component may give rise to other emotions such as satisfaction at completing a task.

4) In time one comes, in certain contexts at least, to seek those positive feelings associated with the aesthetic. One has an intention to achieve them again. In some cases that involves creating one's own forms in line with one's own developed aesthetic sense. Such a person may be motivated to construct a personal view of an academic discipline encountered in a course. They are using an internalised standard of what feels right to master independently the course material, that is, a dependable motivational style which combines cognitive and moral motivations.

5) The degree and type of feeling (aesthetic, satisfaction) that an individual experiences in a particular context determines future intentions in contexts which are perceived as being similar - unless some other factors intervene. If the individual grows in awareness of aesthetic properties and the positive feelings they lead to become more encompassing, the individual is driven to push the bounds of this form of understanding wider and/or deeper. That is, the range of contexts in which personal understanding develops by forming personal, well-developed conceptions would increase, while those in which a person is content to appropriate existing forms (target

understandings) the other levels of organisation identified by Entwistle and Entwistle (1991a,1991b) would decrease. In other words, a person following an intention to create an individual conception of an academic discipline, is not only endeavouring to match external structures but to create an individual, aesthetically pleasing structure.

In the above outline, the intention or goal which was also suggested to be part of the flow of personal understanding, is seen to derive from the motivation of the person, which itself has an emotional flavour. In some cases, emotions associated with creating one's own aesthetically pleasing structure are the motivation leading to an intention to form an independent conception. In other cases, aesthetic emotions may involve more a sense of appreciation or mastery of an already existing form. In such cases, the person seeks out already existing forms. Intentions may, although still having an aesthetic component, be of a more strategic type. In some cases, the emotions may not be aesthetic at all but derive from fear, or a desire to please others. In those cases intentions associated with task completion may arise. It would therefore be possible to develop similar outlines for the other forms of understanding which were suggested by the Entwistle and Entwistle (1991a, 1991b) study. The construction of knowledge objects, or failure to construct them, could also be explained in this way. Figure 13 attempts to show how intention could be conceived of as arising from the various motivations available to the person. It is not aimed at being comprehensive, or to match exactly with the terminology in Kozéki's theory, but simply to give the idea of the kind of work which needs to be done in this area to determine the full range of motivations which may operate, and so give rise to intentions in a particular context. It should also be remembered that the forms of understanding identified by the Entwistle and Entwistle study cannot be freely applied in anything but a speculative way at present. That they are valid in other educational contexts remains to be demonstrated. It seems likely that some modification will be required. This will be returned to in Chapter 8

There are a number of advantages in the formulation of intention which is implied here. Firstly, it allows for an individual to have an intention without a clear representation of the goal. A definition of what counts as an Intentional state is that it carries a specification of its own conditions of satisfaction (Searle, 1983). The above description complies with this definition without the necessity for a full specification of the conditions of satisfaction being available to the individual. One cannot specify to oneself in advance what the state of comprehending something such as a particular academic argument or theory will be. However, the above description allows us to see the possibility of an intention without such a specific condition of satisfaction. The individual is able to specify the general condition of such comprehension, since all that

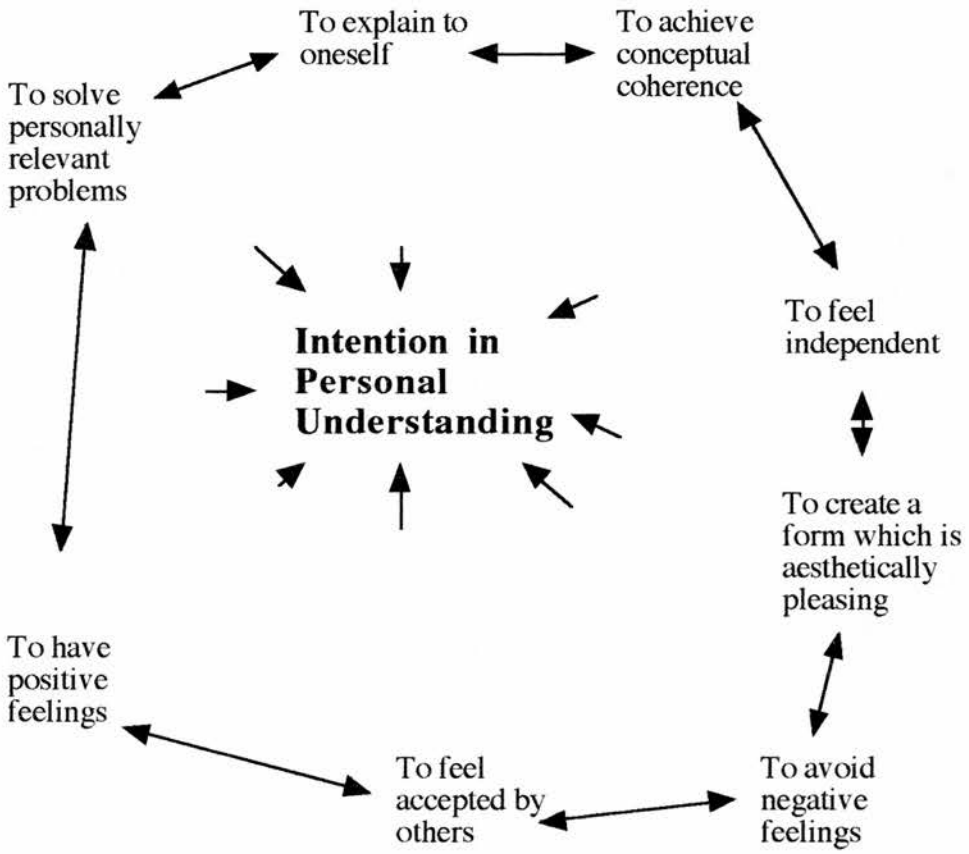

FIGURE 13: INTENTION IN PERSONAL UNDERSTANDING AS DRAWING ON A FIELD OF MOTIVATIONS

Note: The motivations are not in any particular order in the field. Nor is the list intended to be comprehensive. Various combinations of motivation could operate to give rise to the intention. Therefore, the range of possible intentions is not necessarily synonymous with the range of motivations.

is required is a recognition by the individual of the feelings that are associated with that as a goal (in this case, the feelings ranging up to full aesthetic appreciation described above as being associated with structure or form) and some past experience of these feelings. The latter, as argued above, is likely to arise in rudimentary form in the early years of life as children seek explanations from others for the way things are.

Secondly, account is taken of the fact that students feel themselves attempting to master an external structure or create one for themselves (Entwistle and Entwistle 1991a, 1991b). Thirdly, allowance is made for individual differences in personal understanding arising both from different life histories and different perceptions of the context surrounding the target and consequently different conceptions of the target. And finally, it provides a way of meaningfully discussing content and process together. Personal understanding, when adapting to an educational context, ideally involves an intention to seek a feeling of creating a form which is aesthetically pleasing, or at least matches to some degree of personal satisfaction the form of the target presented. The individual will already have a repertoire of mental and physical actions which can be utilised in pursuit of this intention. This repertoire of mental and physical actions are the third part of the flow of intention, process and outcome in personal understanding - the process component. This repertoire of actions encompasses what are generally referred to as thinking skills, problem solving skills or skills of obtaining and utilising information. When sufficiently powerful relative to the target understanding, they will enable these sorts of desirable intentions to be met. At any rate, initial attempts to achieve a form will be limited by this repertoire. At the same time, achievement of a feeling of form relative to a target may increase the breadth of targets for which the repertoire of actions are applicable and increase the size of the repertoire itself. Since we can never have previously intended to reach every goal we set for ourselves, there must be some ability to learn as we go along. The above theoretical outline offers a possible method for this.

It is worth pointing out again that this is intended to represent only one of many possible motivations and intentions which may operate in personal understanding. Aesthetic outcomes are not necessarily the norm.

There seems to be an aesthetic preference for the possibility of simplicity and neatness in underlying conceptual knowledge. However, although conceptual elegance characterises some of our most impressive intellectual products, it does not seem to have been the most impressive design consideration in the whole of our conceptual resources. Our speed of learning and our prodigious memories make it possible for us to respond to the complexity of the world by learning many local variants. (Brooks 1987, page 171)

Perhaps, each variant can have its own aesthetic elegance, but this does not always seem necessary. Other forms of understanding in the Entwistle and Entwistle study (1991a,1991b) do not seem likely to involve an aesthetic appreciation of the outcome.

The above description of intention and its relationship with motivation also seems broadly in line with Frijda's (1988) ten laws of emotion. The following laws seem particularly relevant.

Emotions arise in response to the meaning structures of given situations: different emotions arise in response to different meaning situations. (page 349)

Emotions arise in response to events that are important to the individual's goals, motives and concerns. (page 351)

Emotions are elicited by events appraised as real, and their intensity corresponds to the degree this is the case. (page 352)

Emotions are elicited not so much by the presence of favourable or unfavourable conditions, but by the actual or expected changes in favourable or unfavourable conditions. (page 353)

The intensity of emotion depends on the relationship between an event and some frame of reference against which the event is evaluated. (page 353)

Frijda argues that emotions apply as much to the call of reason as to those of immediate interest. Our voluntary capacities allow us to draw more of reality into the space of emotions and its laws. We can elicit emotions in line with our concerns through the use of imagination and deeper processing

The speculative nature of the above description of how learning, motivation and emotion may be related within personal understanding, is admitted. What it does show, however, is personal understanding is conceptually useful in bringing these concepts together in ways which may be fruitful for explanatory theory in education. The above conception of how personal understanding may develop parallells the specifications derived in the earlier chapters and listed at the beginning of this one. It is also in line with the following statement.

Without the capacity to tie cognitions about possible courses of actions with emotions, it is difficult to make decisions because there is no criterion to drive cognitive reflection in a given direction. The capacities of humans to engage in complex cognitive deliberations and decision making are, it can be hypothesised, a result of humans' ability to experience a large array of emotions that can give many shades and textures of significance to cognitions (Turner, 1996, page 23).

Others may find alternative ways of bringing together the specifications for a concept

of personal understanding and the concepts of learning, motivation and emotion - ways which are better supported by theory and research evidence. However, the concept of personal understanding is made more secure by the demonstration that it can be specified and then described in line with those specifications. The above discussion also points the way to how the next question should be answered.

General principles of personal understanding.

In some of the previous chapters, specifications were derived for a concept of personal understanding, which were used to guide the more detailed exploration of personal understanding in this chapter - an exploration which followed a path set by a list of questions as to what would need to be explained for a full concept to be developed. It is not claimed that we have reached a full and adequate concept of personal understanding at this stage. The aim has been more to show that the concept has meaning, and that such a concept could, in principle, be more fully described. It was noted that, given its complexity and variability, a simple definition of personal understanding is difficult to provide. However, it may be useful to bring together as many features of the concept as possible, in this summary.

1) Personal understanding involves varieties of qualitative transformations by individuals of knowledge and information, and, as it develops, it is influenced by a wide range of factors from both within and outwith the immediate context. These factors include the individual's past, interpretation of the situation and personal goals.

2) Personal understanding arises from the species specific biological and psychological mechanisms of human beings. However, explanations of particular forms of personal understanding derive from relationships with the particular physical and social environments that individuals encounter in their lifespans - the life milieu of persons.

3) The key to handling the complexity of personal understanding lies in focusing upon how biological, psychological and contextual factors influence, and/or constrain, interpretation of context.

4) Personal understanding is an Intentional phenomenon which is adaptational, given the life history of the individual (but see section 7 below for some clarification of this)

5) It follows that it is meaningful to say that a person always has some form of personal understanding. However, personal understanding is multilevelled and

multifaceted relative to a particular context, and may seem more or less complete to both the observer and the person concerned.

6) Personal understanding is unique for each individual since no two personal contexts can ever be the same. However, that uniqueness is constrained by the person's biological characteristics, and by cultural factors such as behavioural norms, social codes, language, and by physical aspects of the environment.

7) Personal understanding occurs in the psychological time of individuals, which derives from the biological, psychological and cultural mechanisms or conditions which give rise to memory, goal directedness, anticipation and other features of Intentionality. Research descriptions of contexts are generally in objective time. In developing the concept of personal understanding, we need to find ways of relating the objective time descriptions of contexts to descriptions of psychological time.

8) It can be suggested that the above relationship between psychological time and objective time can be handled by treating personal understanding as a flow of intention, process and outcome - a flow which is driven by emotion.

9) It is usual to think of personal understanding as depending upon the search by an individual for general patterns or recurrence in phenomena. However, it may also involve other ways of relating to the world - such as fantasy, wonder at the world or some sort of integration of all of these.

10) Personal understanding is a manifestation of human consciousness. As such it involves the shifting relationships between the foreground, or current focus of consciousness, and its background. The background provides the general framework and direction to personal understanding. As such, it involves some representation of the context, even when that is not the immediate focus of personal understanding. In addition, the background plan can become the focus of attention.

11) Personal understanding is not necessarily consistent across all domains or contexts. Despite this, it still retains a strong sense of unity. It is one self relating to the world.

12) Personal understanding involves representational structures and processes involving those structures - either as a background or a focus. The relative stability of the structure as a background is a source of consistency in personal understanding, but the possibility of change to the structure makes conceptual change and other

changes in personal understanding possible.

13) Verbal thought, non-verbal thought, declarative memories and nondeclarative memories appear to have a role in personal understanding, but there is some a lack of clarity about how they interact. It is in declarative memory that a basis for psychological time and personal understanding seem to lie. However, skills stored in nondeclarative memory are involved in personal understanding. The background intentional framework in personal understanding may involve non-verbal thought as well as verbal thought. An analysis of some skillful behaviours suggests that there is a conception of the purpose of the items being used or operated upon, and that this has somehow been encoded along with the skill. Also skills can be developed by focussing upon the adequacy of the results of their use. The idea of a skills purpose may be widened, but it may also be a hindrance to transfer when it becomes part of the nondeclarative memory of that skill.

14) It is possible to construct explanations of how different forms of personal understanding could arise relative to a context by focussing upon how the development of motivation and emotional experience can give rise to different intention, process and outcome flows, although such explanations remain speculative at this stage.

These features mark out a concept of personal understanding, and together indicate its usefulness as a concept at the educational level of explanation, as it can bring together the various areas of explanation, issues and concepts which derive from other disciplines in a way which is consistent with thinking in these disciplines. It is also useful as a springboard from education's own concepts of motivation, learning, and so on, to develop a theory of individual development which is directly relevant to education, and which begins to do justice to its complexity. However, the list of features also indicates much of what is unfinished in the development of its concept and what remains to be explained.

A further conceptual advantage is that the concept of personal understanding, as part of the understanding framework, relieves us from the question of when a person has or has not acquired understanding. It achieves this through a combination of first-order and second-order descriptions (Marton, 1981). Part of the description of personal understanding is what the person experiences it to be, relative to a particular context. If an objective theory of consciousness is possible which treats the objective and subjective as different ways of knowing (Hardcastle, 1996), then an objective theory of personal understanding can, and does, serve the same purpose.

Where possible, attempts have been made to show how the concept of personal understanding relates to educational issues. However, at least, one remaining line of resistance to this may be offered by the reader. Remember how the analysis based on Jack in Chapter 5, offered three, apparently conflicting, cases of personal understanding. It was argued that all of these involved personal understanding of the information being communicated and the context of its communication. What the characters all had in common was a feeling that they had all understood the information in a way which was relevant to them. They all had a personal understanding which relatively matched, or did not match, the intended target, but nevertheless, each believed it to be right. However, our list of characters failed to include the person who desperately wants to comprehend the intended meaning of something, but does not feel that they are making any headway - the pupil who wants to learn some academic material , but who cannot begin to make sense of it. How is it meaningful to refer to this as being any sort of understanding?

This is still a form of personal understanding. The person has failed to adapt to the situation and interprets the situation in this way. 'I am failing to master the requirements of this learning situation.' There will be feelings of frustration at not coping which arise from this interpretation of the situation. Since adaptation is a relative term with a possibility of a perfect fit between organism and environment or person and context, there is also a possibility of not adapting to a context and of being aware of that fact. Teachers are subject to a number of frustrations. One is the pupil who is capable of mastering the course but makes no effort through some perceived lack of relevance. Another, and more heartbreaking case, is the pupil who wants to master the course, makes a concerted effort to do so and for whom teachers try all that they know to help, yet the pupil fails in the end. However, the impact on the overall adaption to one's life milieu will vary in both the pupil's and the teachers' cases. This brings us to the last question in the list at the beginning of this chapter.

Personal understanding and general wellbeing.

We probably all have felt the sort of frustration described above. We may, even as adults, still feel the frustration at not having mastered certain subjects taught at school. Yet, we are able to function socially. We have not been classified as in need of counselling or some other form of mental health care. The point of course is that this is just one context out of the many in a life milieu. However, if the range of contexts in which we feel we are not coping becomes too great, then the balance will swing to not being well enough adapted. Alternatively, if we feel a particular context is significant to our wellbeing, it will contribute more to a sense of not being adapted,

than those which we feel are less significant. The advent of culture made the problem of not being adapted a cultural one.

Culture also places values upon which contexts should be coped with. The value of teaching academic theories and concepts derives from the general values of our culture, or influential groups within it. Culture also places a duty on certain individuals to construct target understandings in a way which allows or encourages personal understanding to cope with them in line with the values. In education this is the role of educationists, but in other contexts it may be the roles of social workers, counsellors, politicians, the clergy, medical practitioners, and even of friends and relatives.

It is through the cultural development of target understandings, that personal understanding can be influenced towards long term adaptational outcomes such as subjective well-being, social functioning and health. In some cases, target understandings may may combine to lead away from these outcomes. The full adaptational significance of personal understanding is found in the way in which it relates to the contexts of a person's life milieu. We shall come to the relationships between personal understanding and target understanding in due course, but first we need to examine the concept of target understanding in much more detail.

Chapter 7
Target Understanding

In the last chapter, it was argued that personal understanding is a meaningful concept, partly because it refers to a developing organism moving through a variety of contexts. Vosniadou (1996) argues for a need to move from a conception of mind as being an information processor to one of mind as being a biological developing system which exists equally within an individual brain and in the tools artifacts and symbolic systems used to facilitate social and cultural interaction.

....mind needs to be conceptualised as a complex biological system with feelings, desires and plans which develop in a physical, social and cultural environment. A system that is not only capable of acting, but also of creating mental representations, of becoming aware of these representations and of changing them, thus creating new cultural tools and new symbolic artifacts. (pages 105 - 106)

Chapter 6 was largely an attempt to to comply with the above by beginning to develop a concept of personal understanding. However, it is also important to find useful ways to describe the contexts and target understandings, and to look for the ways in which they constrain the development of personal understanding. This should lead, eventually, to an improvement in how target understandings can be presented, so as to facilitate the development of personal understanding, in line with valued goals.

On the surface, target understanding is an easier concept than personal understanding. Basically, it can be thought of as being the specifications for adaptation that apply within a particular context . However, within a context there are other human agents, along with the particular individual under study. Part of the context, and therefore the way a target understanding presents itself to the individual, involves the personal understandings of other individuals. Therefore, when an attempt is made to model and describe target understandings, it has to be done in such a way as to include communicative interactions between the various human agents within the context concerned. It has to be a model in which personal understandings negotiate, or, on occasion, fail to negotiate. For example, as will be argued below, target understanding in education comes to the pupil in a combination of a variety of written and spoken forms.

There are a number of issues that arise as we attempt to move towards a model of target understanding.

1) A need to clarify the relationship between target understanding and context.

2) The need to find a form of description for the ways in which target understandings are expressed. Do we consider them as consisting of different forms of representation which are external to the individual - for example, as forms of media (Baynham, 1995)? Alternatively, do we look for a broader and more complex existence within interactions between various agents and the more fixed, or more permanent, parts of the context?

3) In education, text, in the broad sense of written and spoken communications, seems of prime importance in any analysis of target understanding. Can we develop, or appropriate, a description of text which allows us to examine the different types of written text, to consider the relationships between spoken language and written texts, and to examine how texts are embedded in their context of use?

4) Education also involves dialogue, which involves certain rules and expectations of the individuals involved. Literacy theory uses the more specific concept of discourse, which applies to a number of issues (Baynham, 1995). It covers the extended use of language in conversations, letters, interviews and so on. It can also refer to the systematically - organised sets of statements which give expression to the meanings and values of an institution and which determine what can and cannot be said. In this latter sense, ideological positions are articulated.

5) There is also the effect of social and cultural ways of thinking from which certain expectations for education derive. Some of the literature refer to to the effect of 'ideology' in this context. An ideology can be defined as a collection of beliefs, ideas and attitudes which taken together make up a world view or political position. (Baynham, 1995). Baynham also notes that ideologies can be implicit or explicit and that they also tend to 'naturalise' themselves. That is, they behave as if they were the obvious, natural, or common sense perspective. In this sense, ideology means more than a well defined political stance. However, in the context of discussing education, it can have this connotation. Therefore, we will use the broader term of *sociocultural thinking* to include all forms of ideology and social and cultural viewpoints. The detailed analysis of these are beyond the scope of this thesis, but their possible influence on target understandings needs to be acknowledged. One way in which these ideological positions can be seen to be influencing the target understanding is through an educational epistemology.

6) Finally, can these issues be brought together in so that we can describe target understandings in ways which are sensitive to the social purposes, demands and processes with which they are constructed? In particular, can this be done for target

understandings in education?

These issues could be examined in relation to any particular target understanding - not only those in educational contexts. However, it is necessary to keep a more narrow focus for the thesis. In the analysis and development of a concept of personal understanding, theories were drawn upon from outwith the field of educational research, in an effort to suggest the possibility of using the concept of understanding to place educational research as an explanatory activity within a hierarchy of disciplines. Nevertheless, an attempt was always made to keep implications for education in mind. The analysis was driven by an interest in bringing out more clearly what explanatory and instructional theories would look like, and how they would relate to each other. In this chapter the focus is even more specifically upon educational contexts and the relationship between explanatory and instructional theories.

Discussion of the first issue will involve only a brief comment on how target understanding has several senses. There are explanatory senses depending on the focus of explanation, and an instructional sense. The next sets of questions will begin with a look at the possible ways in which target understandings are communicated to students in educational contexts. Following this, the concept of target understanding in education will be shown to describe a complex entity which is embedded in, or influenced by, type of text, dialogues, and outcomes of sociocultural thinking such as an educational epistemology. Through the way in which it is embedded in, and influenced by other contexts, the target understanding fulfils social purposes and demands, and also is a vehicle for social processes. The analysis here will focus primarily on the particular target understandings found in Scottish secondary schools, with special emphasis on those of biology and the other sciences. The assumption is that the same process could be carried out for other target understandings.

Target understanding and context

In the case of personal understanding, context was defined as that necessary to explain personal understanding. There is a need for the researcher to exercise judgment as to how broad, and in what form, the context has to be described in order to explain a particular personal understanding. It was suggested that, in the understanding framework, context could be viewed as sets which are embedded to various degrees in a universal set of all possible targets. If an explanation for a particular outcome of personal understanding cannot be found within the immediate set of interest, we

should look further afield into the target understandings of sets which overlap, or are embedded at the same level within a superordinate set, and the superordinate set itself. In one explanatory sense, therefore, target understanding is part of the context of explanation of outcomes in personal understanding.

However, there is also a sense in which target understandings exist independently of any particular personal understanding. A school curriculum exits in my hometown, within the local school, before mine or any other child attends that school. The curriculum in the school is a target understanding which exits independently of any need on my part to explain my child's personal understanding. It exists with its own adaptational specifications written in. I may need to look into a broader context for an explanation as to why my child's personal understanding copes well, or otherwise, with these adaptational requirements, but they nevertheless have a real existence within that context. In this sense a target understanding is a part of a context with its own 'adaptational' requirements as part of its structure.

Two types of theory can exist relative to this sense of target understanding. Firstly, explanatory theories which seek to explain how the target understanding evolved, and the role which it plays in the institutions of society. This type of explanation would be largely the province of disciplines such as history, social anthropology and sociology. Secondly, instructional theories which seek to specify the form the target should take, in terms of both its content (or structure) and its communication. These instructional theories are usually in place with some sort of institutional backing, whether that be the school itself, a government based authority, and so on, but on occasion they may reflect the idiosyncratic views of particular individuals such as a teacher. At any rate, there is some variation in how targets are presented to individuals within institutions, and one example of this would be the individual interpretations of target understandings by different teachers. They also have a personal understanding relative to the target. This, of course, raises questions of how closely the actual target as found in explaining personal understanding, matches that specified by an instructional theory. We therefore have to attempt to balance the following.

- Target understanding as the context of explanation of personal understanding. For the purposes of explaining educational learning, this is likely to be primarily the syllabuses and other policy documents, the school, the classroom, and teacher presentation and interpretation of the course work. However, it may include factors such as peer group, social background and family interactions. What was referred to as the background set in Chapter 5.

- Target understanding as what the person perceives there to be a need to adapt to - what the individual perceives as being the target. As seen in the discussion of personal understanding, perception or interpretation of the target can be more or less accurate.

That is, it can match or mismatch to some degree objective descriptions for a particular context which have been made by an observer. Explanation of why a target is perceived in a particular way may involve us in broadening our context of explanation, as in one above.

• Target understanding as an evolved specification for adaptation which exists independently of any particular person. This evolution may, of course, have been influenced by interactions of people with it, but it exists for new people to encounter, and perhaps, change in turn. In this sense, a target understanding is one from the full range of target understandings in the universal set, however they have evolved. That is, regardless of whether they are formally or informally specified. They will include cultural customs, common - sense descriptions of reality, common everyday beliefs, as well as formally specified targets.

• Target understanding as what an authority with institutional backing specifies it to be. An institution for the purposes here, is, therefore, an organisation which has the authority or ability to set up some sort of target understanding along with some intended specifications of what adaptation to it requires. Therefore, classrooms can be regarded as being an institution since they

.....are constructed communities with their prime function the creation of conditions for comprehension. (Brumfit, 1994, page 25)

Brumfit also notes that little research has been done on classrooms with understanding as a specific concern.

How target understandings can be described

In the sense that target understandings exist independently of particular individuals, they must have some form in which they present themselves to, or exist independently of, those individuals.[1] What are the ways in which target understandings can be described as existing? In general terms, it can be argued that any aspect of the environment which the person can sense in some way, has a potential for conveying a target understanding. What are some possible examples in education?

Firstly there is the *physical nature of the environment. and events within it..* According to ecological theories of perception (Gibson 1966, 1979) the environment consists of various features which one is able to perceive. These perceivable features include objects, the properties of objects, events, our own actions and even the possibility of actions not yet implemented. The features which the organism is able to perceive or utilise in action, and which Gibson calls 'affordances'. Perception of these things is direct because of the invariiants given by the environment and the way in

[1] Note, it is not being claimed that the target understandings exist independently of people. Only that there is a sense in which they can be described as existing whether or not some individuals (for example, those we are studying) come into contact with them.

which we are structured as organisms. Affordances are relations of possibility between animals and their environments. Dworkin and Goldfinger (1985) also explore the concept of affordance and conclude that affordances are both objective and subjective, because they can only exert an influence if the person possesses the characteristics necessary to make use of them.

Neisser (1987) uses a similar idea of affordances to suggest a role for the concept in the categorisation of objects. An environment offers intellectual opportunities as well as affordances for action. However, this is more complex and less direct than in perception. In this case, we perceive categories of object in line with our cognitive models. There is a basic level of categorisation in which the categories are perceived mainly according to their looks and affordances, so that they appear to be perceptually given. However, Neisser argues that categorisation soon moves beyond appearance. In some domains it comes to be in line with scripts and superordinates which are defined by culture. A bachelor is a category which only makes sense when used within a general model of social life. Campbell (1986) also notes that the possession of a concept generally requires one to grasp a range of related ideas which make the concept available. In other domains, categorisation involves the acceptance of internal or historical criteria which are not obvious to experience. For example, a raccoon is a raccoon, not because of how it looks, but because it contains a particular type of DNA (an internal criterion) or because its family history is that of being a raccoon (a historical criterion). In other domains, we submit to scientific authority. A penguin is a bird because science says that it is. Neisser notes a common thread.

In all this we are driven by a conviction that there is something coherent beneath the surface and beyond the present, and that it is knowable. That conviction is not misplaced. There is indeed much to know: we can see some directly, but we have to figure out the rest.. (page 22)

However, it would seem that the physical structure of the environment is not, in itself, a good medium for target understanding beyond very basic levels.

Although people's knowledge may reflect environmental structure to some extent, it appears that their ability to manipulate knowledge allows them to construct representations that go far beyond those that reflect this structure (Barsalou, 1987, page 116)

It would also seem that culture very quickly starts to impose a structure (or structures) on the way in which we categorise objects. The physical environment in which target understanding may first come to us is supplemented very quickly in our lives by other means of presentation. A full consideration of the possible ways by which culture communicates its structures of interpretation to the individual is not possible here. A

full analysis may involve consideration of the role of gesture (for example, Desmond, 1979; Donald, 1991; French, 1989), emotion (for example, Buck, 1984, Richardson, 1995) and artistic forms of presentation involving pictorial and musical representation. However, the focus here is upon the more linguistic based forms of communication of target understandings. In education, even when these other ways of communicating are involved, language seems generally to be the most important part of the picture.

There is a debate as to whether language determines thought, or thought determines language, within the person's mental functioning (see for example, Ashworth, 1979; Cromer, 1991; Davies, 1986). Regardless of this, however, language is used in constructing and transmitting target understandings, and for negotiating personal understanding. It is the advent of speech and language which makes the relationship between humans as biological organisms and the environments which nurture them quite different from the nature/nurture relationships of any other animal (Washburn. 1978). The model of target understanding which is presented here will assume that target understandings in education come primarily through language. However, this may be a simplification which needs to be extended, particularly in the classroom, where other form of communication may play, at least, a supporting role. The overt messages in language are only part of the actual and possible means by which communication occurs in the classroom (Edwards and Mercer, 1987). Meaning making involves a broad range of activities and means (Ogborn *et al.*, 1996).

Language, of course can be spoken, signed, or written. As a means for conveying target understanding, written language has more permanence than the others. In general, it seems reasonable to state that, in educational contexts target understandings exist initially in written form - in syllabus documents and in text books. Various pathways are, however, possible from these initial forms to the students' interpretation of them in terms of their personal understandings. Figure 14 shows three basic pathways which will serve here for the purpose of analysis. However, this is a gross simplification of the number of possible basic pathways, the combinations of pathways which may occur, and the processes which happen at each stage in the pathway. Nevertheless, it does allow us to begin to think about target understandings in educational settings.

Implicit in this analysis is the notion that there is material with meaning in the original documents, plus vocal utterances by the teacher (and perhaps, on occasion, fellow pupils) which act as intermediaries between this material and the pupil concerned. Ford (1980b), basing his position on Farrodone (1979), defines information as any intentionally transmitted communication, since this allows it to be separated and

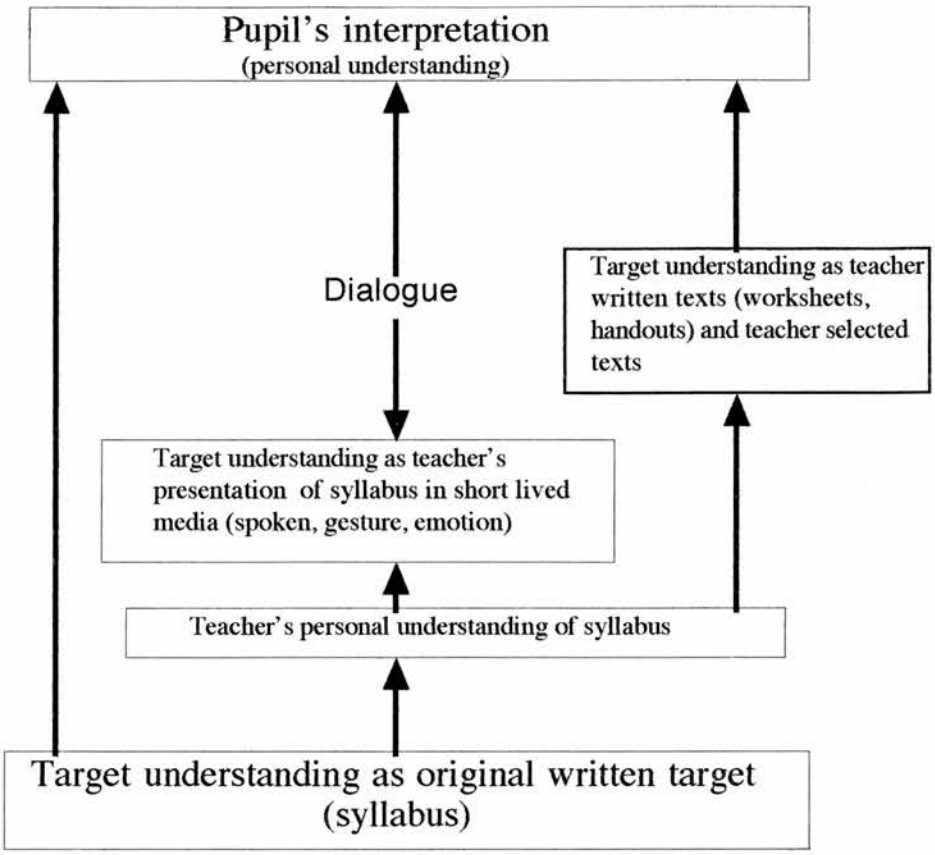

FIGURE 14 : SOME PATHWAYS (MAINLY LINGUISTIC) BETWEEN AN EDUCATIONAL TARGET UNDERSTANDING AND THE PUPIL'S PERSONAL UNDERSTANDING.

Arrows show basic analysis of the flow from syllabus to pupil.. However, depending upon the topic and the ratio of teacher exposition to pupil self paced work, the target understanding the pupil actually encounters will be some sort of mix from the various possible pathways. .

analysed independently of its effects upon the recipient. He characterises the basic premise of an educational system in the following terms. The individual is in a state of not knowing. Therefore, the individual has information needs of some sort. An information need may be a need for information which provides a fact, or it may be a need for information which resolves some sort of conceptual incongruity. An education system has something to offer in the way of providing the information to meet these needs. Certainly, this notion seems to apply to the construction of syllabi, and in this sense implies a one way process from target understanding in the syllabus to the personal understanding of the individual (as in the unidirectional lines in Figure 14)

However, comprehending the intended meaning of information expressed in language always involves a risk for the listener or reader (see various contributors to Brown *et al.*, 1994). The approach advocated by these writers makes the assumption that there is rarely a simple 'correct' interpretation of an utterance. The listener or reader has to make an effort to work out the intended meaning. They argue that there is no guarantee of the intended meaning being satisfactorily grasped, even the words have been correctly identified and the syntactic structure has been correctly worked out. It is within this uncertainty of communication of information, that we can place the variety of personal understanding and target understanding relationships - what was earlier described as the conceptual space of all possible relationships between personal understanding and target understanding.

Figure 14 suggests that we do not only need to consider this variety of relationships between the pupil's personal understanding and the target understanding. We also need to think about the relationships between the teacher's personal understanding, the target understanding, and the resulting individual presentations of the target.

In this view, the form of information presented to the pupil is an important link between representations of reality, which have been created independently of the learner or person, and that pupil's own representation or interpretation of reality. In an educational setting, in which some specification is made as to what information should be presented, we are dealing with senses of target understanding in which a context can be said to exist independently and prior to a particular person's engagement with it. A target understanding in educational contexts, therefore, seems to have the following defining features.

1) It contains information. That is, an educational target understanding is a set of intentionally transmitted communications, which it is believed to be valuable that the

learner receives and makes use of. These communications may occur through a number of different means.

2) An educational target understanding is transmitted primarily through language. In Scotland, this takes the form of being specified in the written text of syllabus documents. This written text and its requirements may then be translated into text books designed to help the learner to cope with the syllabus requirements, or into t handouts and worksheets which are devised by the teacher, or into orally delivered explanations and exposition by the teacher. We can note at this point, that diagrams can be included as part of this translation process. Other forms of communication, such as gesture and emotion, may be used in conjunction with language in oral communication of the target, but these have less immediate significance.

3) Therefore, from the learner's point of view, a target understanding exists in relatively permanent written forms such as syllabus documents, text books, handouts and worksheets, and in short lived or fleeting forms such as oral exposition, gesture and the emotion communicated by others. There are, therefore, senses in which it comes to the learner in a one way process, and senses in which it is open to negotiation in a two way communication process.

Before we examine the ways in which language is used to communicate target understandings, an important issue needs to be cleared up. This view of understanding highlights, and returns us to. a conflict between what are perceived to be the correct goals of education. There is a bias in the way in which target understandings are set up towards a *conduit metaphor* of their communication, which perhaps also leads to a bias away from deep approaches towards surface approaches by the learner (Iran-Nejad, 1990). In Iran-Nejad's analysis, a conduit metaphor is undesirable as it makes academic environments different from the natural ones from which the evidence seems to be convincing that we are all effective learners (See also, Tharp and Gallimore, 1988). According to Iran-Nejad, a *core internal construction metaphor* is more appropriate - the individual uses the same ways of learning which are successful in natural settings. That is, the central internal executive delegates activities to a range of internal systems and resources in a process of internal reconstruction. Tharp and Gallimore, who are influenced by the writings of Vygotsky (for example, Vygotsky, 1978), would add the quality of assistance provided by carers towards performance in new learning to the core internal constructional metaphor. Writers in this vein argue that teachers in schools do not provide the same effective assistance as parents.

At first sight, the core internal construction metaphor would seem to be the one to which all the previous arguments in this thesis have been taking us. Indeed, it is very compatible with the concept of personal understanding. Within the understanding framework presented here, however, both conduit metaphors and reconstruction metaphors have a place. There is both one way and two way communication involved, as we have argued already.

Academic situations are both similar and dissimilar to other settings an individual encounters when growing up. They are similar in that, as with families, peer groups and other social groups, they are contexts to be adapted to. In most academic settings, there are a group of peers and at least one significant adult. In this sense, they are as much natural settings as any other. It is a key point in the understanding framework that an individual adaption to a context can be called personal understanding, and that this adaptation of personal understanding involves an interpretation (conscious or unconscious) of what is required. As already argued, the individual taking a surface approach does so because that is the adaptation to the context which is interpreted as being required, or at least, is the minimum effort the pupil is prepared to put in.

From this perspective, it is the individual's reconstruction of the situation that this type of learning is required - it is one way of adapting (See also, Bereiter, 1990). Also, is this type of rote memorisation, or literal reproduction learning, really not found in natural settings? If we are asked to pass on a message, remember an address or telephone number, we may use similar strategies to a surface approach. Even in natural settings, it does not follow that the full resources an individual has available are used. This applies even in such instances as learning the mother tongue, in which Iran-Nejad claims that the person naturally uses what he refers to as 'the full range of spontaneous dynamic abilities'. These will still only be used in natural settings when the person perceives a need. It can be intelligent in some contexts to learn by rote (Shuell, 1990). In other contexts, a greater amount of reflective awareness is appropriate to the situation or target understanding (Prawat, 1989). Similarly, the quality of assistance from the teacher may not always be a factor. Contexts demanding reflection are presumably those in which quality assistance is most important.

But is it not desirable that we accept the other point that conduit metaphors encourage a surface approach? It may be true that current practice or use of the conduit metaphor both encourages more learners to adopt a surface approach, and leads teachers to give less assistance in reflection, but the conduit metaphor, nevertheless has some relevance to higher educational goals. Firstly, as noted above, Ford's description of education as delivering in some way to learners, information which they are perceived

to need, seems difficult to dispute. It seems to be inevitable that, in setting up a target understanding, there is a conduit metaphor being applied. Furthermore, there is a sense in which the learner must retain some literal correspondence with the original target. To return once more to the idea of forms of understanding (Entwistle and Entwistle, 1991a, 1991b), there seems little point in individuals developing their own conceptions of a discipline, if they cannot describe concepts or theories in that discipline in ways with which others agree, and which approximate to accepted norms. My description of the theory of evolution by natural selection must be in terms which others recognise as being accurate.

A form of conduit metaphor seems an appropriate one for setting up target understandings in education. The personal construction metaphor seems appropriate for how that target is interpreted by the learner. The latter applies even when content is rote learned, rather than constructed or reconstructed in some way by the learner. In addition both metaphors seem to apply to the role of the teacher. The teacher may reinterpret a target to some degree, but still has to present it in a literal enough form for the pupil's own interpretation to be close enough to the original. What has to be examined, is what sort of information is being given to the learner, in addition to the subject content. What does the target itself have to say about appropriate learning strategies, interpretations, the use of internal resources, and the quality of assistance to expect or demand from the teacher? It is not only content which is transmitted from teacher to pupil, but also models of appropriate learning. In other words, in what ways does the target understanding support and convey to the learner, the types of reconstructions we desire them to make. Iran-Nejad unwittingly adopts this type of conduit metaphor when suggesting how education should be conducted.

This involves (a) eradicating all signs suggesting that today's learning is memorisation of isolated materials in preparation for tomorrow's learning of more authentic stuff and (b) orchestrating learning opportunities to closely match authentic learning opportunities of real-world contexts. (page 584)

This may well be desirable, but there are ways in which academic learning necessarily differs from everyday learning in its demands and technical nature (see for example, Doyle, 1983; Laurillard, 1993; Reeve *et al.*, 1987; Shuell, 1990). Perhaps, the answer to improving the way we construct educational target understandings, lies not only in informing students of the ways it is like other forms of target understanding, but also of informing them of the differences? In addition, this information has to be conveyed in such a way that it seems relevant to the learner. In terms of the relevance theory of communication, that means that the learner should not need to use much processing effort to perceive the intended meaning (Wilson, 1994). It, perhaps also involve making some sort of connection with the higher values of life and meaning

(Eisenhart *et al.*, 1996).

Inagaki (1990) points out, that school based discourses, unlike everyday discourses, depend upon text based realities. Students are requested to deal with problems within reality spaces that are created primarily by the use of language. However, an appreciation of the role played by the differences in language environments, both in and out of school is relatively new (Kulkarni, 1988). This returns us to the use of language as a means for communicating the information in an educational target understanding. This use occurs in text and in discourse about that text. The particular texts used in scientific discourse are of particular relevance for this thesis. As we shall see, they create additional difficulties for the pupil in perceiving the target understanding.

Educational target understanding and text.

According to Eriksson and colleagues (1987) in a discussion of the physical aspects of information, a context can be characterised by permanent and semi-permanent textual information and the complexity of that context depends on correlations or relationships between these forms of information. As we noted above and in Figure 14, a student may be faced with a number of texts (textbooks, worksheets, teachers' notes) plus oral explanations. The latter can possibly be regarded as being short lived texts, or, on occasions when pupils are making their own notes, as intermediaries in the students' own productions of texts. There are also the texts of the syllabus documents to which direct access may or may not be available. In this sense, a target understanding is a context of texts. We can begin by focussing upon the various written texts.

A written text is any stretch of written language which can stand on its own as a unit of learning (Davies and Greene, 1984). It can be analysed in terms of the logical or linguistic relations among the sentences or clauses. Alternatively, it can be analysed in terms of the ideas and information conveyed by the clauses. Davies and Greene argue that the latter (a frame analysis) is more relevant to the subject teacher. However, that is to assume that the grammar of the text does not have a role to play in the type of information that is being conveyed, and in the type of thinking it supports. Halliday (1985) describes a view in which grammar can be interpreted as being functional as well as formal. A language is a system for making meanings, and a functional grammar is designed (through time) as a form through which the meanings can be realised. For example, science has its own functional grammar for constructing its

own forms of meaning (Halliday and Martin, 1993). Therefore, it would seem that a science text as a target understanding is characterised in this approach by both the ideas it conveys and the way in which those ideas are conveyed. Furthermore, the ability to convey particular ideas depends upon the form of text and, therefore, assumes the reader's ability to comprehend and use that form.

Let us try to pursue science text as an example of a target understanding. This will enable us to explore further the differences between academic and everyday learning or thinking. Eventually this will lead us to a model of target understanding which combines the conduit metaphor and personal construction metaphors. Science language is a variety of the parent language in which it is being conducted. Halliday and Martin (1993) note the following distinguishing features for scientific language.

1) Perhaps most obviously, scientific language is a system of technical terms. These technical terms form systems of technical concepts, which are arranged in strict hierarchies of kinds and parts. They also have the property of being indefinitely added to. These technical terms may be concrete (can be understood in terms of familiar actions, observations and example) or hypothetical (can only be understood in terms of other concepts). That is concrete concepts can be derived directly from experience, but hypothetical concepts require the application of advanced reasoning (Lawson, 1983). Another feature is that understanding abstract concepts in the hierarchy can only be in terms of those lower down (see also, Howard, 1987). Finally, depending on their use in a particular context, concepts can switch between being concrete and hypothetical. Lawson (1983) gives one example. A concrete use of the concept of habitat would be as, 'the place where an organism lives'. A hypothetical use would be as 'an 'n' dimensional hypervalue, every point of which corresponds to an environmental state permitting the species in question to maintain a steady state'. The latter is unlikely to be encountered in schools, but it does seem possible that concrete uses and hypothetical uses of concepts can be confused. For example, in photosynthesis 'food' has a different meaning from everyday use. It is not something taken in through the mouth to alleviate hunger, but substances which can be used in various metabolic processes such as those which release energy. Failure to make this distinction is confusing for the pupil (Arnold and Simpson, 1980).

2) Less often considered is the technical grammar of scientific language. Over time, science has developed a grammar which allows it to create its own technical terms in its own way. This involves the construction of nominal groups and classes, and deploying these in a way that allows construal of a particular form of reasoned argument. The classic form of this is to take an adjective or verb used in one sentence

and reword it as a noun. That is, by this type of grammatical process, technical terms can be created. For example, a discussion of light being refracted leads to the noun, 'refraction'. What happens is that a piece of text previously providing new information can then be used as a given in the next piece of argument.

The language of science, is by its nature, a language in which theories are constructed; its special features are exactly those which make theoretical discourse possible. (Halliday and Martin, page 8)

Halliday and Martin call this process a grammatical metaphor. A phenomenon which was first construed as a verb (eg refracting) which is a prototypical realisation of a process, is later reconstrued as a noun, and a noun is a prototypical realisation of a thing. This is a grammatical metaphor since, instead of a transformation of one word to another as in a lexical metaphor, it is a transformation from one class to the other.

The result of this is a different construal of reality by scientific language from that found in the language of common sense. According to Halliday and Martin, the latter construes the world as a balanced tension between process and thing. They seem to imply a degree of ambiguity which allows everyday explanation and discourse to proceed in a pragmatic and ad hoc fashion. On the other hand, the language of science quite deliberately construes the world as an edifice of things. Scientific language has the property of holding reality still so that it can be kept under observation and experimented with[2]. In addition, once the scientific community has constructed and agreed its conception of reality, it tends to take that agreed conception for granted (See also, Millar, 1989). However, the learner needs to be initiated into this way of seeing reality (Driver *et al.*, 1994).

Scientific language is not static but evolves, but this analysis suggests that, at present, there is a certain incompatibility between scientific language and that of common sense. To deal with science as a target understanding in scientific discourse, the student has to learn to deal with the forms of discourse used (Greeno, 1992). This would involve mastering the technical terms of scientific language, its grammar and use of grammatical metaphor as described above. In addition, many everyday words, such as volume, solution, burn, take on more restricted meanings in science texts (Fensham, 1988).

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[2] On a slightly different tack, the authors note the contrast between the language that science has developed, and more recent moves to relativity, indeterminism, flow, and so on. They suggest that scientific language is overly determinate in tone for modern problems. This echoes the discussions about time and flow in this thesis. Scientific language may evolve in time to meet these needs by becoming more tolerant of indeterminacy and flux.

Some authors, (for example, Bereiter, 1992 and Kintsch, 1988) describe the same issue rather differently. Comprehension of text (any text, not just science texts) requires the reader to produce two conceptual representations. One is a textbase representing the text content. The other is a situation model which is a representation of the context to which the text is relevant. Both have the possibility of being problematic for the reader. The textbase may be difficult to create, if the inferences the reader has to make are intrinsically difficult, so that there is a failure to attain a coherent representation of what the text is saying. The situation model may be difficult to create if the way in which the text represents the world is significantly different from the reader's representation of it. Both these difficulties seem to be very likely to occur in scientific texts with their own textbases and way of describing reality.

There are other features of scientific texts. Greeno (1992) suggests that scientific language pays careful attention to the distinction between hypothesis and evidence - something which children may need to learn to do, before engaging in scientific thinking. Greeno notes that this needs more research, but it does suggest a possibility that variations in the way (language primarily) in which a target understanding presents itself are part of the adaptational problem in personal understanding to target understanding relationships problems for both the student living those relationships, and for our explanatory theories of them. As Ziman (1980) notes, life in the everyday sense does not depend much on a general knowledge of science. One can live a practical life of wiring plugs, following medical advice, doing the garden and tinkering with the car, without much awareness of the underlying science. The argument in Chapter 6 would, however, suggest that we can do these things because we have some sort of conception of purpose behind what we do. We see a purpose in wiring the plug in the specified manner. We have the purpose of being safe according to rules we have been taught, but perhaps do not know the reason behind those rules. Everyday life may provide little reinforcement for adapting to the variety of language used in educational targets (Kulkarni, 1988). Science is both familiar but different (Fensham, 1988). Its physical products are everywhere, but the language and view of reality are its own. In fact one important difference between a target in science education and in everyday life may be the insistence of the former that taken for granted, everyday phenomena need explaining and submitting to its unique form of scrutiny and analogy. In this process, science education transforms the very nature of what the phenomenon seems to be (Ogborn *et al.*, 1996).

....science teachers have to explain things which do not seem to need explaining at all. How do we see things? Why are our bodies warm? Why does coal burn? Why do hot things cool down? Why is the sky dark at night/? Why do mammals have four limbs? Why are solids hard and liquids runny? Such things seem to common sense to be so obvious that there is no need to explain them. Indeed, nobody asks how to explain

them because they are just the kind of thing we use to explain other things. Why shake the foundations unnecessarily? And yet it is typical of the sciences that they do shake the foundations of knowledge in this way. (Ogborn *et al.*, 1996, page 2. Original emphasis)

We also need to be aware that the language of education may also have its own structure and grammar. If not quite as distinct a variety of language from the parent as is scientific language, the language of the classroom has its own genre. Kulkarni (1988) notes that questions such as, 'Why do we need food?' are not aimed at seeking personal information, but at exploring human physiological needs.

Kulkarni also points out that scientific argument involves use of language found only in the most educated. Language can be conceived as having four possible stages of development. At the lowest level is a descriptive use of language which is not equipped to handle causal relationships in order to present an argument. In the second level, the person can use conjunctives such as 'because', 'hence', 'therefore', but is restricted to single parameter arguments. At the third level, the ability to handle several parameters at once emerges. Finally, mathematics can be used as an aid to greater accuracy, scope and manipulability of thought. Science and science education use the two higher levels. While scientific language is not the only language variety to use these forms, they nevertheless seem to be important distinguishing features from more everyday forms of discourse.

Still further features of scientific language can be discerned, which may have a role in how a target understanding presents itself in educational contexts. Sutton (1992) points to the restraint that scientific texts adopt. He argues that they avoid or play down figurative modes or description, yet Eisenberg (1992) points out that scientists cannot help using metaphors and other figurative language. Like the rest of mankind, it is the way in which they think. (see also, Gibbs, 1994). Where they both seem to agree, however, is that there is a process in which formally figurative language becomes accepted by those who are competent in scientific language as being literal. However, Sutton (1992) suggests that such language does not necessarily have this property of being literal for the learner. Nor can the learner "plug into" the, now dormant, metaphorical usage. One of the teacher's roles is to reactivate such metaphors. Sutton (1992) also suggests that scientists prefer terms with few emotional connotations. The emotional impact of science texts depends upon the elegance of the argument in a style which, although it can be graphic, does not target the emotions

directly.[3]

Finally, a scientific text requires reflective reading, not reception reading (Davies and Greene, 1984). Narrative can be read without reflective reading, although it may occur. However, it is essential in science to, at times, break the flow and reflect about what is being read, to relate it to other material, to question it, and so on.

Therefore, the target understanding found in the texts of science, would seem to have the following features - some unique, and some possibly shared with other forms of specialised texts used by literate members of society.

1) A science text has a technical terminology of its own arranged in strict hierarchies of kinds and parts. Comprehension of higher level concepts can only occur in terms of those lower in the hierarchy, but the overall structure can be indefinitely added to. Concepts can also be concrete or hypothetical, and the same word can be used either way and defined accordingly.

2) Science texts have their own grammatical form. This grammar has evolved in such a way that science can create its own technical terms by a particular form of reasoned argument. This leads to a view of reality which is not compatible with that of common sense language. Science language 'freezes' reality into an edifice of things.

3) Science texts pay more attention to hypothesis and evidence than do everyday texts, in a way which needs practice to master.

4) Science texts, at least those written to impart scientific information and thinking to the lay person, have a particular genre in which one feature is the use of personal sounding questions to explore or elicit general information.

5) Use of scientific language, even in educational contexts, demands a high degree of literacy fully to comprehend or make use of it. In particular, the reader has to to be able to handle arguments in which several parameters are being used simultaneously.

6) Scientific texts play down or normalise figurative language and descriptions. Metaphors become taken as being literal descriptions. Emotional impacts upon the reader derive from the elegance and power with which scientific problems are solved

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[3] For analysis of a piece of scientific writing with evident aesthetic properties in the elegance of its writing and argument, but which, until the end at least, uses words which in themselves do not arouse emotion, see Halliday's (1993) analysis of Darwin's conclusion to the Origin of Species.

or explored, not from a deliberate intention to communicate emotions which may be found in other forms of text.

7) Science texts always require reflective reading rather than just receptive reading. The former requires more effort by the learner and involves breaking from the flow of reading to contemplate what is being read.

8) Science text can shake the foundations of common sense by questioning what does not seem to need questioning and, in doing so, transforms the way phenomena appear to be.

These features combine so that the target understandings of science texts are distinct from the target understandings of common or everyday experience (see also, Martin, 1993). The discipline of science provides a frame for discourse (Hounsell, 1988) in which a particular conceptual framework has to be used, and within which the data of observation belongs and is interpreted. In science texts, there may be a challenge to the way in which we organise experience arising, in part at least, from the way in which language is used (Martin, 1989).

Brown (1990) argues for the similarity between everyday reasoning processes and expert processes. In both cases, learning is being attempted through trying to grapple with ill defined problems. Both experts and lay persons are trying to produce reasonable, causal stories about the world in which they are embedded or situated. This is contrasted with school learning where problems are well defined and understanding is not negotiable. However, although the reasoning is similar between experts and novices, the nature of what is being reasoned with or on is different (see also, Glaser and Bassok, 1989; Kuhn *et al.*, 1988). Lay people in Brown's analysis reason with causal stories and everyday situations. Experts use causal models and conceptual situations. Thus Brown says that learning is

...at core a process of enculturation, of entry into a culture of community and practice. (Brown, 1990, page 277)

Driver and colleagues (1994) offer a similar view of science learning as involving being initiated into scientific ways of knowing.

...leaning science thus involves being initiated into the ideas and practices of the scientific community and making these ideas and practices meaningful at the individual level. (page 6)

Kuhn and her colleagues (1988) argue that everyday thinking and scientific thinking

are different because they co-ordinate theory and evidence in different ways. In particular, the scientist considers the theory and evidence to be separate. Data is regarded as evidence by the scientists, but is interpreted by the lay person as being instances which simultaneously can be explained by the theory and serve to illustrate it. In this view, progress to the ability to differentiate theory and evidence reflects a mastery of a wide range of skills and sub-skills in scientific thinking. Scientists are able to think about the theory as well as just think with it. Brown (1990) argues that education should encourage this enculturation, instead of contrasting with it. This may require us to focus our research beyond the current paradigms of education, in order to find ways to support the types of reasoning used in everyday situations and those of the expert.

However, the above analysis also suggests that we need to take account of the nature of the target understanding itself. Similar reasoning methods between contexts do not necessarily imply similar target understandings. Nor do they necessarily imply similar outcomes which are regarded as being acceptable. Furthermore, the argument and evidence provide by Kuhn and her colleagues leaves open the possibility that similarities in thinking may be superficial. If theory and evidence can be coordinated in different ways, this raises the possibility that, as well as the text based features discussed earlier, a scientific target understanding may be different in other ways from those found in everyday life. For example, Halldén (1988) found that Swedish upper secondary pupils had difficulty in telling what counts as an explanation in the context of explaining the evolution of species, and that what counts as an explanation limits the questions that can be asked.

One distinction that the above features seem to point towards, is that scientific target understandings have a greater coherence built in to them than do those of everyday life. Whereas concepts can be fuzzy in general contexts (Barsalou, 1987, Howard, 1987), science endeavours to give them precise meanings with agreed boundaries (see for example, Duit and Haeussler, 1994, and Halliday and Martin, 1993). Where concepts remain fuzzy, this should be acknowledged for educational purposes (Howard, 1987), and scientists put in a lot of effort into dispelling the fuzziness, or into modifying the boundaries (see, for example, Hawking's, 1988, discussion of changes in the concepts of space, time and atoms). This implies that for this type of target understanding, the individual has to intend to match this coherence in developing personal understanding in relation to it. A form of coherence in personal understanding which may not be required in relation to other contexts. In other words, it is an adaptive requirement of science texts as forms of target understanding, to achieve a coherence in personal understanding which in some way matches, or

parallells, or in some sense allows one to cope with, the coherence in the target. That, of course, is consistent with the argument that a deep approach (Marton and Säljö, 1976a,1976b), intentional learning (Bereiter and Scardamalia, 1989) and the forms of understanding at the top of the hierarchy identified by Entwistle and Entwistle (1991a, 1991b) are all most adaptive in academic learning.

Many may see this level of coherence as marking the only true sense of understanding (see, for example, Greeno, 1977). It is not disputed that it is desirable to be coherent in many contexts, and most notably in academic contexts. However, the argument is made here that this ignores other senses of understanding which are also valid. In everyday contexts, the person may behave with 'common sense understanding', or 'social understanding', in which coherence in the target is less marked. Thus personal understanding can also lack a full coherence but still be a form of understanding relevant to the person and some of the contexts in a life milieu. It is pragmatic in that it is judged against its use for particular purposes (Driver *et al.*, 1994). Also, even well accepted theories in science have some forms of anomalies from the time of their inception (Millar, 1989). Coherence is a matter of degree. This is more consistent with arguments that understanding is not a case of 'either/or' (Nickerson, 1985; White and Gunstone, 1992) and the layering of outcomes (this thesis).

This lack of coherence can be found in personal understanding in everyday contexts, even after exposure to a more coherent view in an educational context. For example, pupils can switch between two ways of conceptualising energy when moving between school and everyday contexts (Solomon, 1983a), and the everyday conception can be anything but coherent (Solomon, 1983b).

Perhaps what is required is some distinction between consistency for the person and coherence in the target. It was suggested in Chapter 6, that consistency in personal understanding has its basis in the psychological mechanisms that underpin consciousness and a sense of self. A person can always still feel that, "It is my understanding", even if coherence is lacking across contexts. The importance for the individual is that personal integrity is maintained. Consistency for the individual means that integrity is maintained even if, on occasion, interpretations of context are not coherent with each other or are not internally consistent. Thus consistency in this sense is not always the same as coherence, although it can be. In fact, it may be possible to argue that the strong demand for coherence is one which derives more from academic pursuits, rather than from everyday living. In the latter, although some degree of coherence in the target may exist, and so places requirements on the individual's personal understanding to have a similar coherence, the demand may be

less strong than in formal disciplines. Common sense may more naturally, and acceptably, make use of rules of thumb, jump to conclusions on limited evidence, and make use of quick - fix theory in the form of socially derived beliefs (Dunbar, 1995)

Consistency for the person is a property of personal understanding because of being a feature of a person with a history across contexts. Consistency pertains to regularities in individual behaviour and the degree to which they cognitively construe situations to be similar or different (Krahe, 1990). Coherence is a property of the target understanding which may or may not map onto the personal understanding a person has developed. When it does, the person is consistent in a coherent way, but, as it was argued in Chapter 6, consistency of the person does not necessarily require a coherence across contexts. Nor, it seems here, does it necessarily require the coherence which a particular context implies is needed. If a target understanding such as the discipline of physics does not have coherence across all its contexts of explanations, it seems erroneous to imply that a personal understanding has necessarily to be coherent, relative to that context. In fact, personal understanding in this context may, at times, involve a feeling of the lack of coherence, and a search for it.

However, that is not the same as saying that, for a context, the achievement of coherence is not desirable. Coherence appears as a marked adaptational specification of certain target understandings such as science texts and, presumably most, academic texts. The physicist will have a coherent personal understanding of each of the theories which are not coherent with each other. When science texts are the target understanding, the core of the conceptual space of personal understanding to target understanding relationships will have a coherence deriving from a particular form of conceptual organisation, use of a particular form of grammar, attention to hypothesis and evidence, a recognition of the need for a reflective approach, and the playing down of figurative forms of language, but all accompanied by a sense of the elegance of the whole.

This is the ideal. However, in educational contexts, this target understanding is translated, as part of the attempted initiation process, into more accessible forms. Some of this translation takes place in dialogues between teacher and pupil (next section), but it also occurs through the educational texts of syllabus and textbooks. The latter may vary from books written in true scientific style to attempts to convey science in the child's own language (Martin, 1993). Some may even avoid presenting any body of content at all (For example, Wray *et al.*, 1987). Martin (1993) sees this as

a retrograde step.

What seems to have gone wrong in the development of science textbooks over the years is that an attempt has been made to make science more accessible by downplaying science literacy. But diluting scientific discourse necessarily involves diluting the science that is taught. As we have seen, science is unthinkable without the technical language science has developed to construct its alternative world view. (page 202)

Clearly, there is a need to research this further. How can textbooks best be written to initiate the novice reader into scientific literacy, without diluting the science? Or to put it another way. How do different types of textbooks change the target understanding from the target identified above to that which the pupil actually encounters in science education? Science is a human activity, but some have claimed that many textbooks perpetuate a dehumanised image of science (Newton, 1988).

Of more immediate concern, however, is the role of the syllabus document in impacting upon the nature of this particular target understanding. It has been argued (Arnold and Simpson, 1980; Claxton, 1991; Simpson, 1988) that school learners do not always experience the target understanding as being coherent. If there is a coherent structure, it is invisible to them.

Secondary science .... was like being on a train in carriages that had blanked-out windows. You were going in a single direction, about which you had no choice. The train stopped at every station and you had to get off, whether you liked it or were interested or not, and pay attention to what the driver told you to. Then you got back on the train and went of to the next station - but because the windows were opaque you could not see the country in-between, so you did not know how the stations were linked to each other. Obviously you were on a purposeful journey, you were going somewhere, and the train driver seemed to know where it was. Worst of all was the feeling that you were supposed to understand the direction of the journey too, even though nobody had given you a map, or let you look out of the train as you were chugging along. So there was a risk that you would come to think that it was your fault that you could not put it all together. (Claxton, 1991, pages 25 - 26)

How much is this the fault of the driver and how much is it the fault of the train and the track? Who asked the driver to take the train with the opaque windows and drive along that particular track with those particular destinations? The role of the syllabus documents, their coherence in terms of epistemology, the forms of understanding which they specify, and the interpretations of them by teachers are all important in this context. Is their coherence within parts, or topics, but not the whole? The impact on pupils in terms of the forms of relationships that develop between their personal understandings and the form in which the target understanding is presented to them, are also important issues. However, before either of these is possible, the concept of target understanding needs to be further expanded. Again, the discussion will be

limited to science education where we will explore the role of the teacher in communicating a target understanding. This will involve looking at the conceptions which teachers hold of the teaching process itself.

Educational target understanding and discourse.

In the previous section, it was suggested that, from the point of view of the learner, a target understanding presents as longer term texts (written) and shorter term texts (spoken). Spoken texts seem likely to share similar properties to written texts in educational textbooks. They can, in principle at least, include spoken texts which are very similar to the texts of real science, with its terminology, grammar, attention to hypothesis and evidence, avoidance of emotional connotations and literalisation of metaphor, demand for a high level of literacy, and a requirement for reflective attention. They can also include a wide range of variations from this norm as teachers translate the texts of science into their own spoken texts of science education. Therefore, it is possible for spoken texts to cover the same range as those of written texts. A range from very dense, very professional scientific language to more dilute forms with little or no scientific content in terms of the terminology and grammar of science, along with a range from little or no emotional flavour to very high and explicit excitement in the delivery (or perhaps, in some cases from little emotion to utter boredom at going over the same ground again).

However, the shorter term spoken texts also have an additional property. They can, again in principle, be open to various forms of negotiation. At one end of the spectrum, there would be no, or very little negotiation. The teacher stands at the front and delivers a talk with a general absence of questioning by the students. In contrast, the teacher would offer no input as to what should be studied. The pupils would explore what ever they fancied, and the function of the teacher would be to facilitate this exploration by providing the necessary materials. Modern practice in Scotland tends to favour the use of a range of approaches within these two extremes, but not the extremes themselves (For example, Caldervale High School, undated; SCCC, 1996a). Therefore, the target understanding being presented in the classroom will shift and vary as various forms of dialogues occur between the pupils and the teacher, but it will retain, as a frame of reference (for the teacher but also, in some cases, for the pupil), the specifications in the syllabus document.

Therefore, one of the constraints on classroom dialogue is the syllabus and its requirements. Edwards and Mercer (1987) distinguish three constraints on classroom dialogue which seems to include the purpose of the syllabus in the first.

1. The responsibilities of teachers as representatives of a culture, and as agents of society.
2. The immediate, practical difficulties facing an adult with limited resources in charge of a group of young children.
3.Teachers' implicit beliefs about how children learn, and how they can best be helped to do so. (page 31)

As well as the syllabus, the first constraint would also include the sociocultural thinking or educational epistemologies favoured by a society. The responsibilities of the teacher arise, in part at least, through this constraint. The third constraint also seems likely to have an affect on the target understanding, and these implicit beliefs about learning will also be influenced by sociocultural thinking and educational epistemologies. The second constraint may have some indirect effect in the target, but it seems that it is more likely to influence the presentation of the target, the perceived importance of the target to the young people, and the division of time between the target and other activities which both teacher and pupil employ. Taken together, these constraints seem to combine into the professional knowledge of the teacher, or knowledge in action (Schön, 1983).

Teaching has been usefully conceptualised as being a cognitive skill with two knowledge components or systems - a knowledge of lesson structure which is supported by a knowledge of subject matter (Leinhardt and Greene, 1986). Application of a knowledge of lesson structure is constrained by particular groups of students. Subject knowledge combines knowledge of the actual content with a knowledge of the different types of content. The content is classified into ways in which it can be taught. The skilled teacher can act flexibly on the basis of a complex knowledge structure, and uses information from the pupils to build up this knowledge base for future use. The implication seems to be that it is the skilled teacher who is able to enter most effectively into a form of dialogue in which the teacher is also a learner. The skilled teacher, in other words, is one who is continually learning how to construct, or modify, a variety of target understandings in ways which best meet the

system, and discern their impacts upon target understanding?

The literature seems to point towards two main theoretical structures upon which teachers base their practice. The first of these theories of teaching is variously described as 'teaching is about telling' or 'teaching as exposition' (Campbell *et al.*, 1997; Iran-Nejad, 1990), 'teaching as content centred' (Smith and Parnell, 1997, Wenestam and Sundell, 1996), 'teaching as applying the delivery model' (Swann and Brown, 1997), and teaching as the 'teacher acting as a conduit or channel' (Iran-Nejad, 1990). The second theory of teaching is described as 'teaching involving

constructive practices or interpretational work' (Campbell *et al.*, 1997; Wenestam and Sundell, 1996), 'teaching as being child centred' (Smith and Parnell 1997), and 'teacher as a facilitator or encourager of pupils' thinking and learning' (Swann and Brown, 1997).

Kember (1997) reviewed the literature of the conceptions of teaching among university academics and identified two broad dimensions or orientations. The first dimension can be characterised as being teacher-centred/content-orientated. The second dimension is described as being student centred/learning orientated (see also, Trigwell and Prosser, 1996). This seems an equally apt conception of the above two sets of descriptions of school teachers' conceptions.

Generally speaking, teachers who hold the first type of theory will have a knowledge of lesson structure which is bounded by a view of knowledge as flowing from the teacher to the pupil in some direct way. Alternatively, they may focus upon teaching goals involving the pupils in merely solving problems, instead of teaching towards goals towards the learning of how to solve problems. That is performance goals instead of learning goals (Schunk, 1996).

It seems fashionable to criticise the teacher-centred/content-orientated view of classroom learning, and certainly an acceptance of constructivist psychologies or psychologies of personal meaning would suggest that, in outline, it is too simplistic a view of the process of teaching and learning. However, in those cases where there is a national syllabus and the model of pathways in target understanding suggested by Figure 14 applies, we have noted that it is difficult to get away from the conduit metaphor altogether. It was suggested that education generally assumes a need on the part of the pupil, and then sets out to provide that need. The teacher at some point has to explain why something is being done, why the knowledge is necessary, or why the view the pupil has will not do when aiming to pass an exam. Teaching, at least in the context of this particular type of target understanding, has to involve some telling and some acting as a channel whereby syllabus aims and objectives are passed on to the student. There are limits deriving from the syllabus which restrict negotiation or dialogue, and the teacher has to transmit those limits in some way to the pupil. The relationship between student and teacher seems inevitably to be more asymmetrical

than some descriptions of classroom learning would assume (Ogborn *et al.*, 1996).[4]

Nevertheless, studies do suggest that teachers with different conceptions of teaching, and a resulting difference in acquired knowledge of practice, can be instrumental in presenting different forms of target understanding. Broadly speaking, child centred approaches give the learner more to do, both in defining what the target is and in determining how to deal with it. For example, Driver (1985) in reviewing literature on research into more traditional teacher led approaches and more child centred classroom practices, concluded that the tendency in the child-centred approaches to encourage children to verbalise their ideas, and to discuss the work in hand, tends to lead towards a greater retention of the study material, to more positive attitudes to lessons, and to more pupil initiation of activities. Of course, this presupposes that the teacher has sufficient knowledge and expertise to organise these types of approaches in an effective way. This may not only depend upon knowledge of lesson structure, but also of subject matter. Teachers may tend to favour a transmission model when they feel uncertain of their own knowledge of the subject being taught (Osborne and Freyberg, 1985)

Kerry (1981) points to another area in which knowledge of lesson structure can influence presentation of a target understanding. Whether the lesson involves whole class teaching or group work, there is, according to Kerry, a need to stimulate pupils beyond a reproduction of information by including problem solving elements. Kerry found that teachers, at the time of this research, spent very little time (10%) on activities in which they actively advanced pupils' thinking by appropriate use of questioning and conversation - even when the class was involved in group work. It was concluded that teachers should look for ways to streamline classroom management in order to free time for this sort of interaction with the pupils. Powell

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3 In fact, pupils may be partly responsible for this situation, and this is not necessarily because of the differences between the reasons they and the teacher are in the classroom. Wenestam and Sundell (1996) note that pupils are at times passively waiting for the learning to happen to them, and the teacher has no pedagogical or didactic methods available to manage such situations. From personal experience, such methods are certainly not suggested in training, which generally seems to assume that pupils are motivated and actively want to learn - at least, they would, if allowed to do so. However, there do seem to be some cases in which pupils do expect learning to happen to them, and such pupils can be very resistant to demands made on them to be active in classrooms in any way, although not through any antipathy to school learning as such. In such cases, there sometimes seems no choice but to 'spoon feed' them in the way they require. Perhaps, as Wenestam and Sundell suggest, there is some ambiguity or lack of clarity in the expected role of pupils which is communicated to them.

(1997) makes a similar point which is based on the experience of being part of a team which spent two years observing and evaluating classroom practice. He notes that some teachers are well organised and have relationships with the pupils, which together allow time for dialogue with individuals and small groups. In terms of the framework here, this implies that the target understanding will be represented more often to pupils and that its presentation will be, potentially at least, more tailored to individual pupils. There will not be only one presentation of the target as the teacher talks to the whole class, followed perhaps by some form of reinforcing activities, but the target represented and varied in the repeat dialogues between teacher and pupil.

Mason and colleagues (1989) carried out an exercise which is interesting in the context of teachers' theoretical approaches underpinning their knowledge in action. Writers of differing theoretical persuasion were asked to describe how they would teach a geometry topic (the slope of a line) to secondary school pupils. The descriptions were then analysed by Danner, an educational and developmental psychologist, for their similarities or differences. The analysis found that the three theoretical approaches set up learning situations which varied in how the problem was represented to the learner, the role given to the learner and the teaching styles used. Danner concludes that this:

...demonstrates that a teacher's perspective - his or her theory of learning- has a very strong impact on what she or he might do as a teacher. (Mason *et al.*, 1989, page 186)

This view can be extended to include a constructivist perspective presented by Watts and Bentley (1989) in the same volume, and which also assumes that the learning environment (or some aspects of the target understanding) are created both by what the teacher does and says, and that this will depend on teacher knowledge of what is possible. (For further discussions of these issues and examples of how teachers differently structure their lessons in order to teach certain concepts see, for example, Burns *et al.*, 1991; Carr *et al.*, 1994; Fang, 1996; Russell and Munby, 1989; Shulman, 1987; Watts, 1994.)

Fang (1996) also notes a change in perspective in research into teacher belief and practices. Previously research had assumed unidirectionality, in that teacher classroom behaviour was conceived as giving rise to student classroom behaviour, which in turn led to particular student achievements. Now, research assumes a circular or cyclical process. Teacher behaviour affects student behaviour which in turn affects teacher behaviour and, ultimately, students' academic performance. How much this can be universally applied seems arguable. In some cases, teachers apparently adopt a transmission model of teaching in order to minimise the effect that students can have

on the lesson (Osborne and Freyberg, 1985). It may be more of an ideal that the cyclical version should apply: perhaps it does apply in more cases than not?

The author's own feeling is that, in Scottish schools today at least, a transmission model may be used to minimise pupil contribution to the lesson in order to get through a crowded syllabus. It is not always used because that is the only one known by the teacher, or the only one for which skill is possessed. Pupil contributions have to be given a body of time which is not consistently available in particular course for a particular group of pupils. However, many teachers also seem open to giving the pupils some time to contribute to the lesson, where this seems possible. We should beware of assuming that all teaching based on either a child-centred or transmission viewpoint is the same, or that the teaching of any one class or course by a particular teacher, necessarily reflects the full professional knowledge. Any teacher will testify that a particular lesson works differently with different classes, and that sometimes the pupils leave no choice to the teacher, but to take a very controlling role. In those cases, the more modern research perspective identified by Fang seems correct, but perhaps not in the way envisaged. The pupils contribute to creating a situation in which a one way transmission does occur. This may mean that some aims in the syllabus to do with the form of learning and thinking required may be omitted. How the translation of the target understanding in the syllabus occurs is strongly influenced by the knowledge of practice and the aims of the teacher. It also suggests that the presentation of a target understanding can be influenced by other constraints which lead to a use of a form of teaching, even when the teacher has the knowledge of others.

The concept of *motivational climate* seems pertinent (Ames, 1992b). A motivational climate arrives from the teacher's knowledge of lesson structure - perhaps, in a form of co-operation with the pupils. Alternatively, we can argue that, through their knowledge of lesson structure and classroom practice, teachers are creating some of the adaptational requirements of the target understanding. According to Schön (1987), knowledge of this type, the knowledge of a professional in action, derives from the contexts of the particular problems the professional is trying to solve. However, in the case of teaching, the above discussion suggests that theoretical orientations will influence the way a teacher goes about solving the problems of presenting, creating, or interpreting a target understanding in order to present it to the pupils.From this perspective, successful teachers are those who have a professional theoretical knowledge which can be used to make the adaptational requirements of the target understanding seem salient enough to the pupils, so that those particular adaptational requirements override others which may be applying to the context. In these teachers'

classes, pupils become motivated because they come to feel that what is being taught has adaptational significance.

Therefore, target understanding has features which derive from the nature of the discipline being taught, from the degree to which the discipline is translated or 'watered down' in the syllabus, and from the professional knowledge of the teacher and the theoretical basis upon which it is founded. In some cases, it may involve a state of flux, as pupils contribute to the negotiation of the target understanding. However, if there is national and fairly detailed syllabus, this will always constrain the options for the teacher - no matter how skilled in the use of a variety of teaching strategies or models, that teacher is. As well as reflecting a body of knowledge and skills to be taught, a national syllabus must also inevitably carry sociocultural assumptions arising from the political, institutional and social structure from which it derived. These assumptions influence the way in which a target understanding is set up, and place certain expectations upon pupil and teacher.

Target understanding and sociocultural thinking.

Any analysis of sociocultural thinking begins to take us into the fields of those disciplines which lie above educational theory in the hierarchy of disciplines. That is, into research into the role of education in particular societies, national and cultural assumptions about what education is for, who it is for, and so on. A detailed analysis of this type is well beyond the scope of this thesis. However, again for the sake of some completeness in the concept of target understanding, the importance of sociocultural thinking, in influencing the forms which target understandings take, needs some illustration.

The concepts used in connection with sociocultural thinking can be identified with political positions, but the concern here is with a more general sense of the background of beliefs, ethos and opinions (including, if necessarily, political viewpoints), which influence behaviour and action in a particular context. As noted above, the more general term of sociocultural thinking was preferred over ideology to avoid a confusion with politics.

It was noted above that sociocultural thinking tends to naturalise itself, in that it becomes the obvious or common sense perspective to take. One illustration of this can be found in a comparison of American and Asian teachers descriptions of their goals in teaching and observed differences between classroom practice (Stevenson, 1992).

American teachers seemed to tend to view their main tasks as being to evaluate and meet the needs of individuals in a patient way. The net result of this appeared to be classroom situations in which pupils worked alone and seated, with a reduction in the opportunity for interactions with the teacher or other pupils, and, paradoxically perhaps, less feedback on performance being given to the pupils. Asian teachers, in contrast, tended to emphasise clarity and enthusiasm which seemed to lead to classrooms with more feedback to the pupils on performance, more effort in relating what was being taught to everyday lives, more active participation by the pupils in producing and solving problems, and more interaction with the teacher.

Neither set of goals seem particularly controversial. However, they presumably derive from sociocultural differences in thinking between these parts of the world, so that each is emphasised at the expense of the other. Sociocultural thinking (perhaps research based, perhaps not) has influenced the way in which teachers think about their roles. It has also affected the ways in which target understandings are presented and the ways in which pupils are expected to interact with them. The tone of the Stevenson article is one which suggests that the Asian teachers are being more successful and, carries an implication that the assumptions of American teachers need to be questioned. Whatever the rights and wrongs in this case, it does suggest that there are times when we need to examine the broader assumptions behind what we do, or what we are being asked to do, in setting up target understandings. Assumptions of this type can lead to different presentations of target understandings[5]. At the very least, this would enable us to be clearer as to when instructional theories reflect explanations deriving from those disciplines below education in the hierarchy, or influences from the broader contexts in which it is placed.

Sociocultural thinking can also be thought of as local to a school. For example, in the case of science there may be perceived differences in the status of biology, chemistry, physics and general science courses (Croxford, 1997). There may also be a general consensus that science is for boys and that, of the sciences, biology is the most socially acceptable for girls (Croxford, 1997, Garrett, 1986, Harvey, 1985). In more general terms, schools may differentially emphasise political approaches, bureaucratic approaches, market approaches or public relations approaches in the particular mixes which they use in curriculum design (Eraut, 1990).

Individual schools can be very different in terms of what they believe is possible and

[5] It is perhaps also a contributory source of different conceptions of learning in the pupils. Purdie and colleagues (1996) found that Australian students have a narrower, more school based conception of learning than did Japanese students. The latter saw learning as not only related to what happens in school, but as a lifelong experiential process leading to personal fulfilment.

right (Reid *et al.*, 1987). Local forms of sociocultural thinking serve to bind the members of an organisation in a belief in a common purpose or cause (Handy and Aitken, 1986). According to these authors good thinking of this type will have at its heart;

..... *a philosophy of education, a clear understanding of what people are being educated in and for - what the school stands for in other words - as well as a consistent approach to how that education is to be done and the sort of standards that are to be looked for. This philosophy needs then to be articulated , not just in the formal prose of the school's prospectus, but in the everyday utterances and behaviours of its members. An ideology needs its outwards and visible signs; only then does it begin to be the uniting system of influence it should be.* (pages 78 - 79)

Clearly, a full model of a target understanding needs to make it possible to take into account the broader forms of thinking which have influenced its design and presentation (see also Ranson and Martin, 1996). However, it will be recalled that a target understanding was conceived as being a set embedded in other sets within what amounts to a universal set of all possible understandings. Relative to a particular classroom, sociocultural thinking is a set within which the activities of that classroom take place. Therefore, classroom practice may be influenced by sociocultural thinking as well as by the nature of the discipline being taught, theories of teaching, and so on. In addition, the choice and application of an educational epistemology may be based not only on educational research, but also on sociocultural thinking. On some occasions and depending upon the purpose of explanation, it will be necessary to take sociocultural thinking into account,. On other occasions it will not be required. It is, however, necessary to the full comprehension of what a target understanding is and how it arises to recognise the influence that sociocultural thinking could have.

For example, we have noted the possibility that we may regard outcomes in understanding as deriving from a hierarchy of conceptions of what type of understanding is required. It is being suggested that some conceptions lead to a higher level outcome than others. However, Raven (1990) lists some barriers to the achievement by the Scottish educational system of, what he calls, the development of high level competencies in its students. One of these barriers is the prevalent beliefs about the nature of educational management. Raven perceives these as centring upon a perception that innovation is the prerogative of management. Thus education does not have a structure and climate which favours innovation by the teachers themselves,and this climate is also communicated to the students in terms of what it is important to attend to and how things should be done. Thus, presumably, stifling further development of a culture of innovation.

If an explanation of target understanding seeks to explain innovation (or lack of it) in teacher presentation and students' conception of understanding, it seems that sociocultural thinking will have to be taken into account. Certainly, the earlier arguments for the importance of taking educational epistemologies into account are given some support. They are one channel through which sociocultural thinking influences the syllabus. A choice of instructional theory may not only depend on explanations from explanatory theory, but also on choices made from a sociocultural perspective. By contributing to making the occurrence of these forms of choice more explicit in curriculum theory and practice, the framework developed here contributes to making them potentially more rational. However, the way in which they influence educational practice remains open to further analysis. We will now move to an examination of how a target understanding can be represented as existing within the issues described above.

Integrating, means of communication, text, discourse and ideology - is it possible?

At the beginning of the chapter, it was asked if the issues arising from text, discourse and sociocultural thinking could be brought together so that target understandings could be described in ways which are sensitive to the social purposes, demands and processes with which they are constructed. In this way, explanatory and instructional theories could be brought together in a common framework, which, while distinguishing between them, would make possible the development of both. Instructional theories provide data for explanatory theories which, in turn, guide the further development of instructional theories.

The thesis offers two ways in which these sort of issues could be approached, depending upon the explanatory purpose. The first of these is suggested by Figure 10 (page 90). In this case, personal understanding is considered in relation to the target understandings a person has met in a life milieu. Each target understanding could be analysed, as appropriate, in terms of the context it occupied, the type of text it consisted of, or the social purposes and processes encompassed within it.

The second approach is suggested by Figure 15, which can be applied to the form of educational target understanding discussed in this chapter. A form of target understanding which stands in some sort of relationship to an academic discipline, such as science. In this model, the target understanding expressed in the syllabus is seen as having been developed and set up under the influence (arrow I1) of whichever

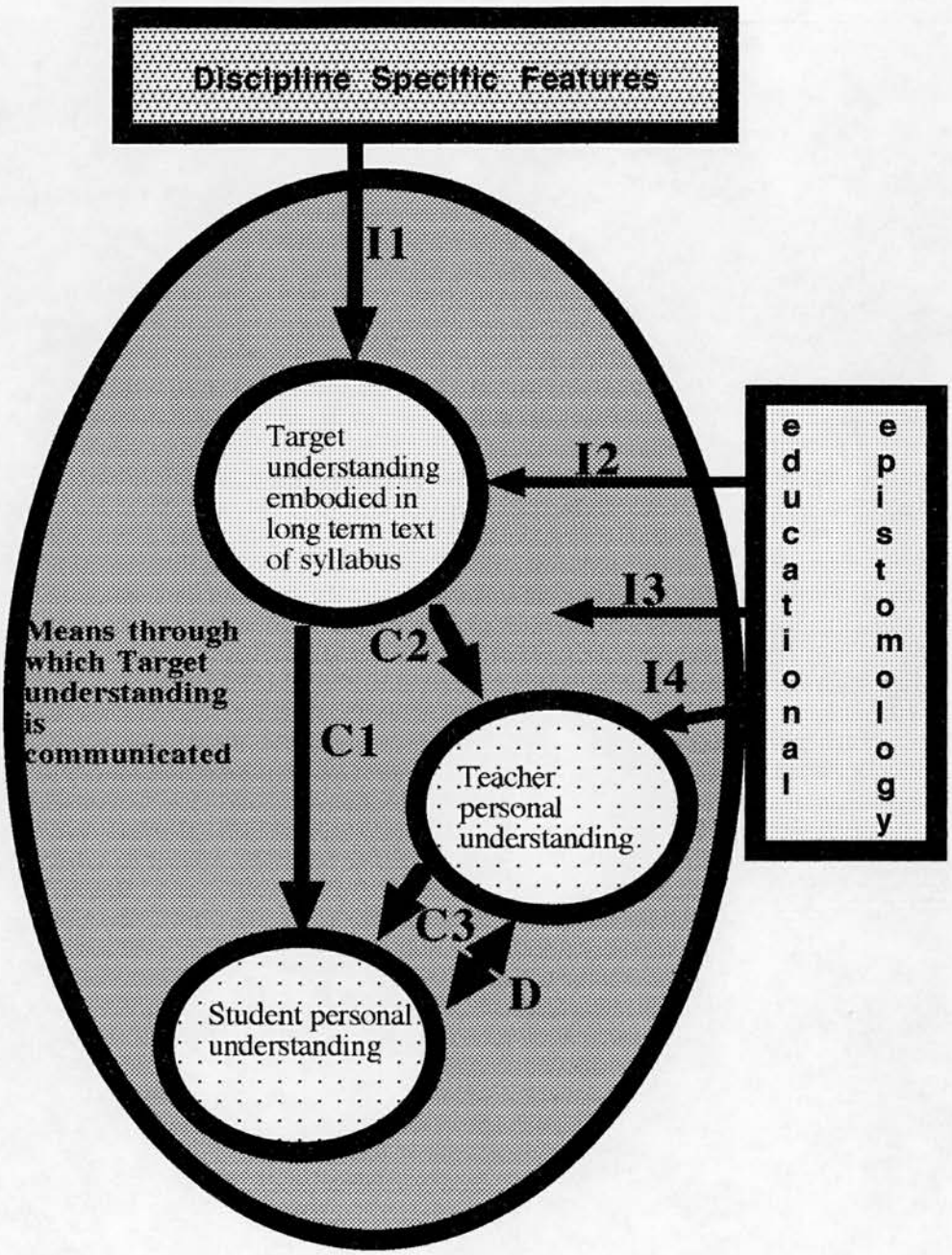

FIGURE 15: EDUCATIONAL TARGET UNDERSTANDING RELATED TO MEANS OF COMMUNICATION, EDUCATIONAL EPISTEMOLOGY, AND ACADEMIC DISCIPLINE
Arrows marked 'C' (for communication) and 'D' (for dialogue). show the pathways from Figure 14 slightly simplified. Those marked 'I' show influences on the syllabus, the actual forms of communication used and the ways in which forms of communication are used.

academic discipline applies (biology, history and so on), and also by a range of educational epistemologies (arrow I2). Some of the issues of the relationship between science as a discipline and science as a target understanding in education were touched upon in the above discussion of science texts. This target understanding can be passed to the student by the various pathways discussed in relation to Figure 14 and the conception of teaching the teacher uses (arrows C1, C2, C3 and D). The whole process of communicating the syllabus target to the student is seen as being embedded in a variety of means - for example, written and spoken texts, Educational epistemologies influence the choice of means of communicating the target understanding (arrow I3)

.

The conceptions that the teacher has of the syllabus, of its purpose, and of teaching will also be influenced by educational epistemologies (arrow I4). The teacher may choose a transmission model of teaching and communicate the target through written media (information handouts) and exposition. In this case, teaching may primarily take arrow C3, and minimise D. Alternatively, a more pupil centred approach may be used which would lead to more dialogue. Teaching would then follow arrow D more strongly, although C3 would possibly still be involved through written material.

Educational epistemologies would also be one way in which sociocultural thinking influences both the means of communicating a target, and the teacher's personal understanding of that target. The educational epistemology box could be placed within broader sets representing the sources of sociocultural thinking. A similar analysis is possible fort the academic discipline. All this, however, would, as noted earlier, be a field for more sociologically orientated research. nevertheless, it mat serve to provide superordinate guidelines as to what needs to be explained by explanatory theories of understanding in educational contexts.

This conceptual model brings together descriptions of a target understanding, (what is to be understood) along with descriptions of how it can be communicated, descriptions of how it is thought it should be communicated, descriptions of why it is thought important to communicate it, descriptions of how it is actually communicated, and descriptions of degree of the correctness of its formulation in order to meet its declared purposes.

The conceptual model also allows the exploration, and perhaps eventual integration, of the types of contextual questions raised in section 1. Target understanding can be explored as;

- A context of explanation of personal understanding,

• The context as perceived by the individual, an evolved specification for adaptation, and
• A set of information, procedures and evaluations which have been specified by an institution or authority, and so derives from one or more instructional theories.

As with personal understanding, the concept of target understanding brings together a number of concepts which are relevant to explaining understanding in educational contexts, and clarifies some of the issues relating to these concepts. The conceptual model of target understanding, and its presentation in educational contexts, therefore allows us also to explore the relationships between explanatory and instructional theories, and, eventually, more soundly to build the latter upon the former. The next chapter will further develop the idea of the conceptual framework as both a stimulus for research aimed at developing explanatory theory, and as an aid to linking research and practice.

Chapter 8
Overview and conclusions.

This chapter aims to set the framework for explaining understanding in a theoretical perspective. The previous chapters have largely been concerned with building up an argument for viewing understanding in a particular way, and have introduced, or borrowed, concepts at various points. Therefore, it seems useful to consider the theoretical status of the understanding framework and its main concepts. This should serve at least three purposes. Firstly, it will further develop the distinction between explanatory and instructional theories in education. Secondly, it will point towards the follow up work which needs to be done, if the framework is to be developed or modified. Thirdly, it should enable this framework to be contrasted with other views of understanding in education - in particular, the performance view. Out of these discussions, the way in which the framework can be used to develop the curriculum can then be further clarified.

In Figure 1 (page 4), an outline of the framework upon which this thesis is based was presented. Figure 16 is an expanded representation of the framework presented in the previous chapter for explaining understanding in education. It derives from the analyses and argument of the thesis, and show, as far as possible, the main ideas. The ellipse represents an educational context such as a classroom. In the context presented here, students and teachers are following a prescribed syllabus, but the diagram could be altered to include contexts in which the teacher has more responsibility for the subject matter taught. It also represents a form of syllabus drawn from an academic discipline,[1] although the framework could be modified for school subjects which followed a different pattern. Interactions in this setting would depend on the form of instructional theory being applied, as well as the personal understandings of the people involved. Instructional theory would depend in part on the educational epistemology being applied. Ideological and cultural thinking about the nature and purpose of education may also influence what occurs in the classroom, either through the formulation of an educational epistemology (as shown in the figure), or in other ways which are not shown.

There are several things which cannot be shown well in this diagram, as they are generally beyond the analysis of this thesis, were touched upon only in a general way, or are too complex. Firstly, the components, inside and outside of the ellipse form part of the universal set of all possible understandings as defined in Chapter 5, but they do so in different ways. The persons involved will have encountered different

[1] In Scotland, representatives from appropriate academic disciplines are usually to be found on the panel devising the syllabus

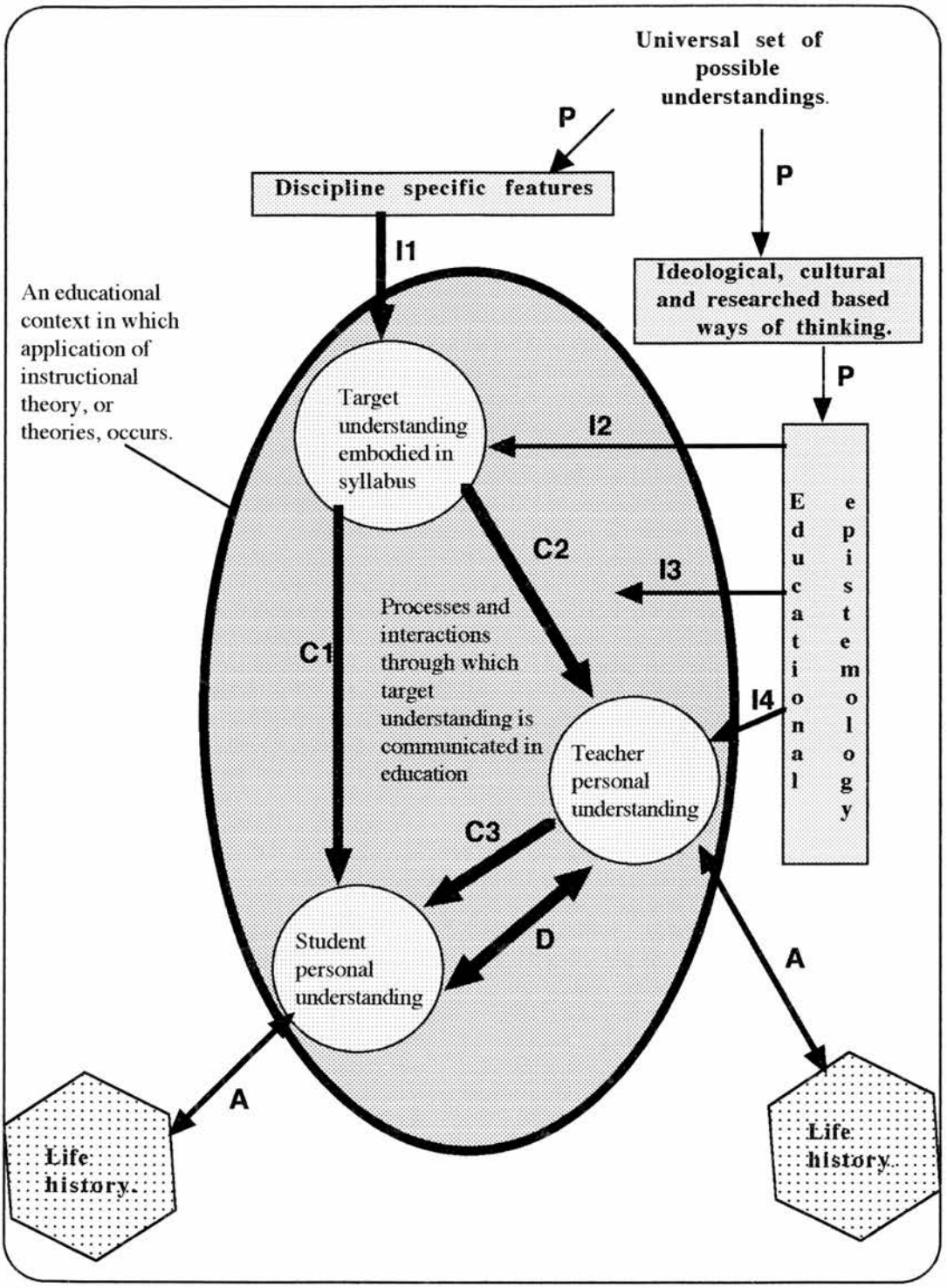

FIGURE 16: A CONCEPTUAL FRAMEWORK FOR EXPLAINING UNDERSTANDING IN EDUCATIONAL CONTEXTS.

Key to figure 16

A arrows. A representation of the need to recognise that personal understanding and target understanding relationships within a particular context also have an adaptational significance within the life milieu of the person.

P arrows. A variety of cultural and social processes which are beyond the analytical scope of this thesis, but which help to put explanatory theories in education within a disciplinary context.

I arrows Processes which influence the form of target understanding a syllabus represents, and the form of target understanding it becomes through its presentation. The influences are:

I1 from the nature of an academic discipline (eg Biological science influence on a school biological syllabus)
I2 of current educational epistemology on syllabus structure.
I3 of current educational epistemology on syllabus presentation or communication.
I4 of current educational epistemology on teacher's personal understanding of syllabus.

C and D arrows. Processes and interactions through which a target understanding is communicated.

C1 Student or pupil has direct access to original syllabus document and develops a personal understanding of it.
C2 Teacher develops a personal understanding of syllabus by a) direct access and/ or b) a combination of direct access and in service training.
C3 Teacher chooses a transmission model of teaching and communicates the syllabus through oral exposition and writtenhandouts aimed at transferring information.

D Teacher chooses a pupil centred approach to teaching and the syllabus is communicated through dialogue between teacher and student.

Note: 1) Ways of thinking based upon ideology, culture and research (sociocultural thinking) may also influence the processed represented by the I, C and D arrows more directly than through an educational epistemology. However, in order to simplify both the diagram and the analysis, this possibility is left aside at present.

2) Other contexts encountered in a life milieu will also derive from the universal set.

sets of target understandings in their life milieux. This was fairly extensively discussed when the concept of understanding as adaptation was examined, and the 'A' arrows remind us of this. It is from this aspect that the background relevant to the explanation of variations in personal understanding could derive. It may contribute to the background in consciousness or intention, and would also be the aspect of the framework in which the influence of personal history and relationships could be explored.

The other components of the framework which are outside the ellipse help to set educational theory in the context of a hierarchy of disciplines. As noted earlier, any full exploration of these components is beyond the scope of this thesis, but some of the more immediately relevant aspects were touched upon - for example, the way in which educational target understandings are embedded in broader contexts. Also simplified in the diagram of the framework is the interactions in the classroom. For example, in discussing these interactions, peer group relationships were mentioned, but this is omitted from the diagram. Hopefully, however, the diagram serves as a useful concept map of the framework for explaining understanding which has been developed around the idea of personal understanding to target understanding relationships. In the following sections a slightly different approach will be taken to this key idea. The idea of personal understanding and target understanding relationships will be presented as a core hypothesis which serves as an 'organising idea', around which a conceptual framework is constructed for explaining understanding.

A core hypothesis.

Brooks and Wiley (1988) attempt to develop a biological theory of evolution which is consistent with Neodarwinism, but provides, as they see it, a better integration of ecological and genealogical processes. As part of the discussion, they make what seems to be a useful distinction between a core hypothesis and more specific hypotheses. A core hypothesis is usually a fairly simple statement of what is believed to be the case, but which is not directly open to empirical verification. That is, there is no simple prediction which can be made or used to test a core hypothesis. Instead, it receives its support through the other hypotheses which derive from it, and/or the way in which it makes possible the integration of previously disparate areas of research or thinking. Brooks and Wiley cite two examples of core hypotheses: 'Evolution of species occurs through natural selection' and, their own, 'Evolution is an entropic process'.

Viewed in this light, the key idea in this thesis can be presented in a stronger form in which it represents a provisional statement of a core hypothesis.

Understanding in educational contexts is the range of forms of relationships which exist between personal understanding and the range of target understandings in a life milieu.

Brooks and Wiley do not elaborate further on the idea of a core hypothesis. However, the above examples seem to have some features in common. Given that they are not amenable to direct empirical testing, their prime function seems to be narrative. They suggest ways in which a phenomenon should be thought about. On the other hand, the hypotheses which derive from these core hypotheses are, potentially at least, explanatory in a predictive way. They offer predictions which can be tested, and also offer some explanation of why certain outcomes occur.

These core hypotheses, although relatively simple to state, share a degree of conceptual complexity. Evolution, natural selection, entropy, understanding, personal understanding, target understanding, and life milieu are all abstract concepts brought together in some form of relationship by a core hypothesis. The concepts themselves are either developed or refined by the authors of the core hypotheses, or are borrowed directly from other sources, but the core hypothesis brings them together in its own way. Also, other concepts are found to lie behind those in the core hypothesis. Behind natural selection we find concepts such as variation, inheritance, environment, niche and so on. Brooks and Wiley use entropy in a way which seeks to bring together form and function, information, historical constraints and so on. The way that the framework developed from the core hypothesis of this thesis integrates and synthesises several related concepts has been a recurring theme in previous chapters.

A final feature shared by these core hypotheses is that a great deal of effort has to be taken initially to defend them and argue for them. Evidence and supporting ideas have been pulled in for their defence, in an attempt to persuade of their explanatory value. To date, this has been successful for Darwin's core hypothesis and less successful for that of Brooks and Wiley, which has met with some opposition. However, even for Darwin, immediate acceptance was not forthcoming, and the furore surrounding publication of his theory is well known. Brooks and Wiley have provoked debate, some of which has led them to modify the ides they derive from their core hypothesis, but not the hypothesis itself. Stating the key idea in the stronger form of a core hypothesis make it more vulnerable to attack and debate, but also open up some criteria against which it can be judged in the longer term. The ultimate value of the

core hypothesis of this thesis will depend on three main criteria[2]. A provisional acceptance of this core hypothesis should lead to:

- a continuing integration and synthesis of a set of related concepts in ways to provide a fuller and more convincing description of the nature of understanding;
- an indication of how more specific hypotheses can be derived which could, in principle, be tested; and
- the possibility of being fully developed into an explanatory theory of understanding, which along with cultural or social values and choices, would underpin instructional theory.

The extent to which the core hypothesis seems to meet these three criteria will now be considered, treating each criterion in turn.

The core hypothesis and related concepts.

In both working towards the core hypothesis and in developing the concepts of personal understanding and target understanding, the previous chapters have brought together a number of concepts

1) In Chapter 2, use was made of concepts which describe what is thought to be basic to educational activity. These activities include the conceptions of teaching and learning which are used by those engaged in educational practice, along with conceptions of assessment and its purposes. These concepts of teaching, learning and assessment were described in terms of educational epistemologies - an epistemology of intelligence, an epistemology of problem solving, and an epistemology of mind. These concepts also provided a means of linking theory and practice, and levels of explanation, as is described below.

2) In Chapter 3, the idea of a hierarchy of levels of explanation was used to place educational theory in a broader theoretical context. These levels of explanation reflect the different disciplines which explain human development, functioning, behaviour, culture and society. It, therefore, formed a basis for the development in subsequent chapters of a framework for explaining understanding in educational contexts, which took account of both biological and contextual constraints. The framework can also be used to derive insights from other disciplines as to the nature of understanding, as

[2] It is not suggested that this thesis is in the same class as Darwin's, or that of Brooks and Wiley. It is not a measure of their conceptual quality that the three works share some conceptual features and forms of argument. Nor, does a sharing of features suggest a sharing of importance.

well as bringing together different areas in which understanding has been discussed.

3) The framework for explaining understanding was also shown to allow for the mutual development of both explanatory theory and instructional theories in education. This can be achieved by taking up the concept of Intentionality and placing it in an evolutionary framework. It allows us to distinguish biological and psychological mechanisms for understanding from the particular understandings developed in certain contexts, such as educational contexts. From this emerges a concept of understanding as adaptation, which connects to the concept of biological adaptation, but is distinct and more complex, since it occurs across the life milieu of the person - that is across the range of contexts a person encounters. Thus, the framework can provide an explanation which brings in the historical constraints from the lifespan development of the person, while focussing upon an immediate context.

4) In Chapter 4, concepts such as plasticity and developmental constraints on plasticity were used to extend or supplement the above view of adaptation. They provided a biological explanation which gives this more complex view of adaptation greater plausibility. Along with the view of the role of the brain as being a constructor of representations, they also showed the need to include an anticipatory component in explaining human understanding - it can incorporate predictions of future outcomes. Together, these concepts present understanding as inevitably unique for each individual. It was suggested that a concept of a psychology of personal meaning could be applied to those psychologies which help to explain how individuals can have a unique, or individual, understanding. This type of psychology also seemed to provide the most effective support for applying an epistemology of mind.

These concepts were utilised in a preliminary framework for thinking about research and practice. The concept of forms of understanding was also included and proved useful as a preliminary description of outcomes in education, and of how these outcomes relate to educational epistemologies. From this, it was later possible to consider outcomes in understanding in relation to theories of, and approaches to, teaching.

5) In Chapter 5, the concept of personal understanding was introduced. Personal understanding refers to how individuals interpret, the demands and degree of relevance of a context. In addition, the concept of target understanding was used to describe the adaptational requirements of a context. Using these concepts, it was argued that the framework can allow for a range of outcomes in understanding - from lack of engagement in a context, to various degrees of mismatch and match between

personal understanding and target understanding. In this way, other important areas of research, such as those into language understanding and social understanding, could be brought into the picture and concepts shared with them. For example, the concept of 'common ground' was used to help comprehend the degree to which personal understanding is shared, or requires to be shared, for successful interaction between individuals.

6) The concept of target understanding was shown to allow us to specify the context for which our explanations are relevant, and to broaden the context of explanation when necessary. For example, if an outcome in understanding cannot be explained by referring to the conditions in the immediate learning environment, there is a need to look into the broader life milieu of the individual in order to find the adaptational significance of the outcome. Thus, the concept of target understanding allows educational contexts to be placed within other contexts. It is also possible to start from broader educational contexts and analyse them into narrower components. Therefore, as well as aiding explanation, this framework allows questions to be asked about the role of education which are relevant to the development of instructional theory.

7) A concept of conceptual space was introduced to cover the range of possible outcomes between personal understanding and target understanding, with a core of outcomes which is more viable relative to that target. In this way, the need for instructional theory to ask when particular educational goals have been achieved by the learner was retained, while not limiting explanatory definitions of understanding to their achievement.

8) In Chapter 6, the concept of personal understanding was able to bring together a number of important concepts in educational and psychological research. These include approaches to learning and concepts of learning goals and student involvement; intentional learning and incidental learning; intention, process and outcome; forms of representation; human universals; consciousness; conceptual change; metacognition; forms of memory; and the relationships between cognition, motivation and emotion.

9) It was also suggested in Chapter 6 that the concept of personal understanding may be useful in our attempts at trying to develop a more adequate language for dealing with experience. It is able to bring together concepts such as objective time and psychological time, reciprocal determinism, psychological flow, and iteration .

10) In Chapter 7, the concept of target understanding was shown to have the potential

of bringing together a number of issues. This set of questions contains some which are beyond the analytical scope of this thesis. A full consideration of them depends upon insights from disciplines above education in the hierarchy. Nevertheless, they are important in completing the picture of the scope of the explanatory framework. The issues include the question of authority in education, ways in which contexts develop, peer group interactions, the effect of social background of pupils, communication in education, the role of the teacher and theories of teaching, analysis of the nature of educational requirements which derive from an academic discipline and how they may contrast with other types of target understanding, social expectations for education. Again, the important point is made that the explanatory framework which has been offered in this thesis allows for the mutual development of explanatory theories and instructional theories in education.

Obviously, the way in which these concepts, and others, are integrated into the framework will require further refinement - even if the core hypothesis itself proves to be useful. However, a perception of error, even major error, in the use of subsidiary concepts does not necessary imply rejection of the framework. The strength and potential of the framework lies in the way in which it brings together a wide range of research focused upon issues of understanding and education. The core hypothesis also has the potential for stimulating a continuing debate about the nature of how best to integrate this range of concepts, and a consideration of which additions should be made. As long as that function is served by the core hypothesis, then how the framework and its background concepts are visualised and developed is a matter for debate and shared expertise. The core hypothesis can meet the first criterion, and the way in which it does leads us to the second. One way in which the framework would develop and change is by suggesting more specific hypotheses, and empirical studies to test those hypotheses.

Some hypotheses.

Any empirical test for the whole framework within a single research design is implausible. However, it is possible to suggest one general study which would cover the central portion of the framework (figure 16) in a fairly complete way. This study could progress as follows.

Firstly, by interviewing those responsible for setting up a syllabus and careful reading of the syllabus documents, a clear description of the target understanding which is being specified for pupils could be formulated. In drawing up this specification careful

note would need to be taken of any differences between representatives from academic disciplines and/or more advanced forms of education and representatives from the level of education concerned. The former may be more interested in conceptual content whereas the latter may be more influenced by a particular educational epistemology. Also, representatives from a higher level of education may be using a different educational epistemology.

Secondly, teachers could be interviewed to elicit their personal understanding of the syllabus and how they believe it should be taught. Observation of the teachers would need to supplement this, particularly in light of the Langer study mentioned above, in order to try and tease out the relationships between the aims of the teachers and what they can actually achieve in practice. As Ogborn and colleagues (1996) suggest, when we consider the role of teachers in communicating understanding, alongside the role of pupils in constructing understanding, we must then look closely at what the teachers are doing and how they are doing it. Such an analysis, they argue, has been neglected in the move towards constructivist theories of pupil learning.

Thirdly, pupils could be interviewed to determine their conceptions of understanding relative to that specified in the syllabus and to the teaching they receive. Given the danger of oversimplification, these interviews would need to be supplemented by careful and detailed observation of the behaviour and interactions of the pupils concerned, along with an examination of their work If teachers can lack a vocabulary and knowledge to aid in their aims, so too can the pupils.

Fourthly, the nature of the examination, or other assessments, and the results obtained by the pupils could be examined. The exam can be set against the specifications for understanding in the syllabus, the personal understandings of the teachers, and the personal understandings of the pupils.

If, together, these steps in research began to build up a useful picture of the relationships between personal understanding and target understanding, and generated further research questions, then the core hypothesis and framework could be considered more secure. Some more specific hypotheses are now suggested, although appropriate research designs are only indicated.

The framework has made much use of the idea of forms of understanding as a preliminary description of the type of outcomes which may occur in relationships between personal understanding and an educational target understanding. These original forms of understanding were derived from one particular context - revision

for final degree exams. It was suggested in Chapter 4 that the term 'conceptions of understanding' could be used in this framework, as the question of their applicability to other contexts is researched. Perhaps, in other educational contexts additional conceptions of understanding may be identified. Figure 17 is a reminder of the original description from which a number of hypotheses might be tested. For example,

a) *The original forms, or conceptions, of understanding apply to a wide range of educational contexts and levels.* In principle, this hypothesis could be tested in a single, relatively large scale study covering a wide a range of educational contexts, and drawing on various methods in collecting data. Interview techniques similar to the original study may be used would be appropriate but accompanied by substantial written work and observations of pupils' interactions with teacher, tutors and peers. A questionnaire on approaches to learning may prove useful, along with questions demanding extended written answers on a broad topic which requires an integration of ideas from across the course. The aim in all of these methods would be to get as much data as possible on how the discipline or educational context is perceived, and what the learner thinks is required to understand it. If the original descriptions emerge as being adequate, or even if additional ones are required, the core hypothesis and the framework will be supported. Implications for instructional theory could then be more securely derived.

There is already confirmatory evidence in the research literature that the description of conceptions of understanding is along the right lines and that similar conceptions are found in other contexts. For example, Tan and Novak (unpublished) found four conceptions of understanding in school physics students. The first conception of understanding involved a perceived need by the students to make connections between the physics experiments they did in the classroom and their experiences from elsewhere. However, they did not seem to develop abstract physics concepts. Such students felt they understood the lesson content in a concrete way. However, the structure they were developing does not seem to depend on either the course or the discipline. Therefore, it might be that these students are intermediate between those students who have no clear structure in their personal understanding, and those students who seek to use the course structure in reproducing its content.

The second conception of understanding identified by Tan and Novak, seems very similar to the latter form - reproducing course content within the logical framework of the course. Tan and Novak describe this conception as involving the student in following the rules and methods of each lesson, with the aim of being able to carry out

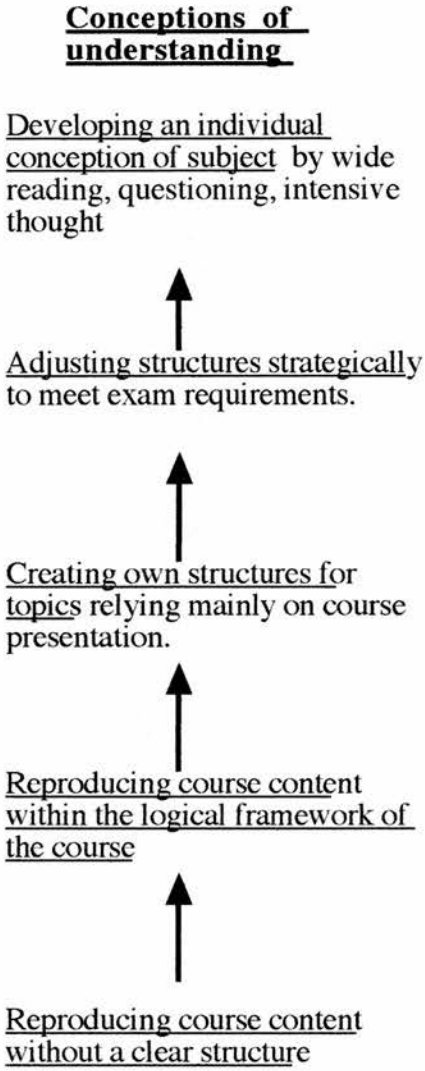

FIGURE 17: A POSSIBLE HIERARCHY OF CONCEPTIONS OF UNDERSTANDING. Based on Entwistle and Entwistle (1991a, 1991b).

the same thought processes, and use the same concepts and procedural rules, at a later date in similar lessons. The focus seems clearly to be on the course, and the difference in description seems likely to result from the different educational contexts - that is, in the difference between the context of science lessons and the context of revision.

The third conception of understanding in the Tan and Novak study is demonstrated when students relate new physics ideas to other physics experience and knowledge. Understanding now involves knowing the relationships between physics concepts. In some cases, as they developed in this conception of understanding, such students would relate ideas under headings similar to those found in textbooks. This seems similar to creating one's own structure, but relying mainly on the course structure. However, since textbooks were also used, there may be some adjustment being made which links it to the above level in Figure 17. Interestingly, other students in this category developed their own ways of organising concepts and would use this to try to understand any new physics concepts they were taught. They, therefore, seem to be developing their own conception of the discipline, but it is not clear from the Tan and Novak study to what degree this involves wide, independent reading and thought. Again, the different context of study may be crucial.

It is harder to match the fourth conception of understanding with Figure 17. It seems, in a sense, to go beyond the descriptions found there. In this case, the students in the Tan and Novak study have started to conceptualise their everyday experiences through physics concepts and principles. It includes a personal idea of what physics is about. It is the opposite of the first conception described by these authors, since students now ask themselves how they may use physics to explain everyday events. In the first conception, they would ask how does this idea in physics relates to what they know from experience. Some students also show evidence in this conception of developing a scientific "world view", which both values scientific concepts and explanations, and recognises that they are not perfect.

In conclusion, Tan and Novak note that students in a physics classroom show a range of meanings, or conceptualisations, of understanding. Some of these fit with those of the teacher and some do not. They also note that few students reach the last two conceptions described.

Another study (Burns *et al.*, 1991) looked at students' conceptions of understanding in sixth year chemistry. They found a continuum with, at the extremes, a knowledge orientation and a coherence orientation, and these orientations do seem to map to an extent onto Figure 17.

In a knowledge orientation, students looked for feedback from assessments and the teacher and the focus was on recalling relevant information. Generally speaking, the students studied said that understanding took time, but they way this time was spent varied. Some depended only on their notes. Others would look up a text book, but any more than one became confusing. Presumably, they could not develop their own structure for integrating information. Others used several books in seeking solutions to the problems in their understanding which they had identified. The authors found that only students with a coherence orientation could show some sort of linking information. A knowledge orientation, at best, led only to the recall of isolated pieces of information. In a coherence orientation, intrinsic assessment of understanding occurred when students recognised understanding for themselves. Such students also looked for an order within which the subject matter all fitted into place and had relevance. They wanted to know what terms meant, and the reasons behind things happening. Also, although the authors tend to describe their results in this polarised fashion, they also mention a meaning for understanding described as 'usually coherence; but also knowing how.' In this meaning, understanding involves knowing how to get the answer; knowing how to follow the working in a problem; and knowing the rules. Given the different research context, this is similar to the middle positions in Figure 17. As a description, it also bears an interesting resemblance to the epistemology of problem solving.

These studies are encouraging in the relationships they share with the conceptions of understanding in Figure 17. However, they do not offer definite confirmation of the underlying framework, as they had different research aims. Much more work would need to be done across contexts before we could be more certain of these similarities, and before we could be confident in the generality of our descriptions of conceptions of understanding.

b) *At higher levels of education such as PhD level, the balance of forms of understanding will be towards the top end of the hierarchy, whereas at lower educational levels, where the same discipline is taught, the balance will be towards the bottom.* This hypothesis could be tested within the above hypothesis, and with a similar research design, but may be worth testing separately as it has implications for the type of educational pathway we would seek to provide for our students. Given the likely difficulty younger subjects would have in being introspective on their understanding, interview evidence would again need to be supplemented by examination of written work, classroom interaction, and so on. Also, if differing forms of understanding began to emerge in different contexts, the scale of the study would need to grow to the same sort of dimensions as the above.

So far, in the research literature, there only seems to be indirect evidence that forms of understanding will be differently balanced at different levels of education. What evidence there is depends on the assumption that a deep approach to learning is associated with the higher forms in Figure 17, and that the surface approach leads to the lower forms. Biggs and Rihn (1984) have, indeed, found that university students had higher scores on an inventory measure of deep approach than college students. However, both groups showed deep and surface approaches being used concurrently. The authors explained this finding by suggesting that some learning tasks in educational contexts warrant a surface approach, which is consistent with the identification of a strategic approach and a need in some subjects to build a knowledge base before developing understanding (Entwistle and Ramsden, 1983). Although using different concepts of learning approaches, Baird and White (1982) also found a relationship with outcomes of understanding. Students, who used strategies involving continual elaboration and extension of the information along with processes of interrelating and rationalising, achieved deeper understanding than those who focussed on content in more limited ways.

Different educational contexts also seem, differentially, to encourage different approaches to learning. Selmes (1985, 1986) found a greater emphasis by teachers on a deep approach at Higher level than at 'O' grade in a Scottish secondary school. Burns and her colleagues (1991) found that the teachers in their study used a transmission model of teaching and suggested that this may be one cause of the low number of students adopting a coherence orientation. Langer (in press) found that American children are not encouraged to think deeply in educational assignments. Contexts at lower levels may only have the goal of exposure to content and so do not encourage the forms of knowledge structuring required for higher levels of education (Spiro et. al., 1988). These authors also suggest that the outcomes in these lower levels of education, even when regarded as being successful, may actually hinder the acquisition of more advanced forms of knowledge.

Generally it seems, we would expect the higher levels of education and the other contexts which encourage or require more elaborated forms of learning or a deeper approach, to encourage the higher forms of understanding suggested by Figure 17. However, the evidence remains inconclusive, and research into the validity of the above two hypotheses, together or separately, would improve our knowledge of the ways in which understanding develops in different contexts.

The framework also incorporates the idea that relationships between personal understanding and target understanding can occur through various pathways. In

Scottish education, these pathways generally involve the teacher as an intermediary between the intended target understanding and the personal understanding of the student or pupil. Hypotheses can also be formed and investigated about the relationships between teaching styles and forms of understanding pursued by the students.

c) *A student-centred/ learning-orientated approach to classroom management will encourage forms of understanding which are towards the top of the hierarchy and are more integrated.* Again, this would necessitate the gathering of evidence in a number of ways, particularly with younger subjects. However, some evidence (Campbell *et al.*, 1997) suggests some support for this hypothesis, in that those students who prefer a deep approach to learning, or who hold what the authors refer to as a qualitative conception of learning, prefer teaching strategies of a constructivist type, whereas the more traditional and expository approaches favour the adoption of rote learning (See also, Molander, 1997). If the deep approach to learning is, indeed, associated with the higher forms of understanding, then those teaching methods which encourage it will also encourage the higher conceptions of understanding. In Chapter 7, the arguments for each teaching approach were considered. However, Langer (in press) has identified a complicating factor. In a study of teachers from different disciplines, but who were all keen to advance the thinking of their own pupils, the nature of the discipline may itself determine to some extent, the form of thinking required. For example, in sciences the thinking has to be more content specific than in literature studies. Based upon actual observation of teachers, she suggests that it is too simplistic to view all situations in which teachers are controlling the lesson and guiding the pupil as not being concerned with advancing disciplinary thinking. The problem lies in teachers not having a pedagogical vocabulary sufficiently to flag up their aims to the students.

A complementary direction in research could be pursued by investigating the educational epistemology which is being applied in a context. This would enable the study to take in the influence of the syllabus and associated documents.

In practice, this sort of research may be more difficult to set up than is apparent at first sight. One solution would be a cross cultural study, if equivalent levels of education were found to utilise clearly differing epistemologies for equivalent courses and age groups. Alternatively, a longitudinal study may be sufficient. Other categories of hypothesis can also be pursued. These would be more specific to some of the background concepts in the framework and to personal understanding. For example, hypotheses can be framed which are aimed at developing our knowledge of the role of

motivation and emotion in personal understanding .

d) *For a context, it is possible to identify a type of motivation and emotional outcome for each of the forms of understandings which students adopt.* This would require research instruments and techniques capable of identifying motivations and the associated emotions. One strategy may be to use an interview directly to examine the relationships between personal history, motivations and emotional outcomes, as well as forms of understanding.

Finally, we may speculate that:

e) *Forms of understanding the hierarchy are found as giving a strong feeling of knowing, a confidence in the rightness of retrieved answers, and a feeling that future learning in this context will be relatively easy.* This could involve the use of interviews prior and subsequent to a task involving the testing of a person's understanding. The prior interview would be aimed at teasing out the individual's confidence in understanding, relative to the coming task. The subsequent interview would assess the degree to which they felt they had been successful, and compare this with the reality.

There are other hypotheses which could be formulated and pursued around the core hypothesis. However, it is hoped that the above discussion provides sufficient evidence that that the framework presented here is rich in possibilities for further research. In addition to opening up these possibilities for research, the framework also opens up academic debate and research about, for example, the evolution of consciousness and personal understanding; about the evolution of modes of representation and personal understanding; about the similarities and differences between everyday contexts, the contexts of professional academic disciplines and educational contexts; and about how to use concepts such as intention, process and outcome in order to better describe psychological flow or iterative processes in personal understanding. Again this list is by no means exhaustive, but is intended to give a flavour of the possibilities for integration of many educationally relevant issues around a common core.

Conceptualising understanding in terms of relationships between personal understanding and target understanding seems potentially fruitful in explanatory terms. There is, however, an alternative framework describing 'teaching for understanding' which has been developed by researchers at Harvard Graduate School of Education. They have argued for a performance view of understanding, as

indicated earlier (Chapter 5). It is worth evaluating the claims of the framework developed in this thesis against those made by the Harvard study.

The framework and the performance view of understanding

The performance view of understanding has been developed as part of Project Zero (Gardner, 1991-92, 1992 -93, Wiske, 1997), and the notion of understanding performances has been described most recently by Perkins (1997). He acknowledges the difficulty in questioning what understanding is, but he believes that there is a simple and practical solution. We can ask, "When do we recognise understanding?" The answer is, that we ask someone to do something which demonstrates it. In doing this something - explaining, solving a problem, building an argument - the person puts understanding to work and may also develop it further. He suggests that we recognise understanding through what is called a 'flexible performance criterion.'

Understanding shows its face when people can think and act flexibly around what they know. In contrast, when the learner cannot go beyond rote and routine thought and action, this signals lack of understanding (Perkins, 1997, page 43).

Perkins elaborates further. Understanding a topic means being able to perform flexibly around the topic, and he asserts that

the flexible performance capability is the understanding. (page 44)

Perkins now adds a further concept - that of understanding performances. By definition, these are performances that go beyond the rote and routine. An understanding performance always involves a 'stretch' for the person. In Perkins' view they always lead to advances in understanding, as well as displays in understanding. Although important in life, well-practised routines do not demonstrate understanding. Perkins does acknowledge that the distinction between understanding performances is not absolute but is one of degree. The degree to which a performance involves understanding depends on the task and the person. In task terms, remembering one's own phone number is no more than a well-practised reflex, while remembering a friend's number may be a small scale understanding performance, if it involves some informed guesswork as to what digits apply. In individual terms, whether a performance is an understanding performance depends on the level of sophistication of the person. A physics problem for a high school student which is an understanding performance may be mere routine for a physics graduate.

There seems to be something wrong with this view. It acknowledges that

understanding develops, but implies that earlier demonstrations no longer count as understanding simply, because they have become automatic. The implication seems to be that, as persons move from high school to graduate level, they no longer show understanding of the high school physics problem because they no longer show what Perkins counts as being the 'correct' understanding performance. One wonders if the graduates feel the same way. Do we feel that understanding develops in this manner? Do we feel that something does not involve understanding because we do it easily? Surely, if asked, the graduate could step out of the routine performance of a high school level performance, and explain to a novice how it is solved. This, surely, is what teaching is all about.

Perkins might reply that this is a new understanding performance. The task has changed from one of solving the problem to one of explaining it in a new situation. Nevertheless, one is being asked to assume that understanding is achieved, and then lost to the routine, and then achieved again. There is, however, another string to Perkins' argument.

He contrasts his performance view of understanding with the representational view, which suggests that understanding depends on the learner having, or constructing, some sort of mental model or representation of what is to be understood. Performances arise because the representation is there first. Perkins distinguishes two types of representation. Those representations which can be 'manipulated' or 'run' in the mind, and those representations or action schemas which lie in the background, but somehow guide our actions. Perkins suggests that the representational view of understanding and the performance view explain understanding in different ways, and that the latter is to be preferred. Why? Perkins' first point is to argue that we can have a mental model without understanding something. A mental model does not do anything by itself. The person must operate on or with the model. This seems unremarkable. Why would the mental model be there if the person is not going to do something with it, or has not done something with it in the past? Why should a biological organism expend energy formulating or maintaining a representation which is never used, or never has been? What sense is there in having a mental model which does not play a role in understanding something?

Perkins answer seems to be that possession of the mental model does not guarantee knowledge of how to use it. If you are told to think of electricity as fluid flow, you might not know what to do to reason with that image. Suddenly, understanding is no longer a matter of degree. You either know what to do with the image or you do not. Furthermore, your understanding or lack of it is judged from an outside perspective,

not from yours. How might you judge the situation? If you are a physics student puzzling about electricity, you may seize upon the proffered image as the answer to your problems, and begin to explain a number of electrical phenomena. You have sufficient common ground with the person offering the model to use it as intended. On the other hand, if you have no interest in explaining electricity and are asked to imagine it as fluid flow, provided you know what the terms in the model mean, you will still have an image. However, you will not use it as intended. Instead, you will interpret the situation as one in which someone gave you an image which has no immediate relevance to you. You do not understand the situation from the perspective of the presenter of the image, but you do understand it from your own perspective. Nor is it sufficient for Perkins to say that those of us who use the model only partially as intended are not demonstrating understanding, unless he wishes to go back on his statement about understanding being demonstrated in various ways and degrees according to task and person.

We have been here before. What Perkins is missing is that representations, whatever they are, are not formed in isolation from the context in which they are formed. The question of what they are is open at the moment (see discussion in Chapter 6), but they are formed with a purpose, and that purpose derives from the interpretation of the context and the life history of the person. It may not be a conscious purpose, but would be an adaptational purpose within the person's life milieu. That is, the purpose of the particular representation derives from the form of the relationship between personal understanding and target understanding. Levels of explanation below the educational level may be free to simplify explanation by glossing over this role of purpose in representation, but for educational explanations it has a major importance. Persons will not engage in personal understanding to target understanding relationships, in the forms we desire, unless it fits in some way with their adaptational purpose. This form of relationship, as discussed in earlier chapters, may be one of total lack of engagement or various forms of match or mismatch. Remove this form of purpose and we cannot begin to explain how different people respond in different ways to the same learning task, how they interpret that task in different ways, how they take different approaches to learning, and how they show different forms of understanding. Background representations which guide our actions are also an important part of understanding.

It seems more safe to rethink the concept of representation rather than abandon it altogether. For example, the genome can be thought of as being a representation of a plan for an organism. It is not a point to point mapping. Neither is it a set of immutable rules, as the discussions on plasticity showed. There is scope for variation

in its application. However, it is a premise of current biology (Maynard-Smith, 1966) that information does not pass from the organism to the genome. In other words, the genome functions as a representation of the plan of the organism and how it works, but the organism has no direct access to it, or control of it. Also, the genome is only activated when specific environmental conditions are present. To all intents, the representation is not present from the perspective of the organism, except that certain events take place in its lifespan.

How then can we best summarise Perkins' position? Firstly, it remains an instructional theory as it does not distinguish sufficiently between explanation and instruction. He decides in advance what counts as demonstrations of understanding in learning contexts and defines understanding accordingly. Its apparent strength lies in the fact that, in the educational contexts in which Project Zero is applying itself, it is desirable that personal understanding to target understanding relationships involve the sort of flexible performance he describes. Similarly, in his analysis of learning and teaching, Perkins provides what may be a useful basis for instruction aimed at building understanding performances upon each other. Other authors in the same volume in particular Mansilla and Gardner, (1997) and Hammerness *et al.*, (1997), make use of the concept of understanding performances in what can be taken to be a more developed instructional theory. It is as an explanatory theory that this position is inadequate, since understanding is defined solely from the perspective of the observer, and not from the subjective perspective of the person. The framework offered in this thesis allows for both perspectives.

In summary, the performance view of understanding has the following problems which are not shared by the personal understanding to target understanding framework.

- It does not distinguish sufficiently between explanatory aims and instructional aims in educational theory, and falls into the latter. Therefore, any attempts at explanation are from the perspective of an instructional theory, rather than that of an explanatory theory.
- It prematurely closes the door on the debate about the nature of representation and its role in human behaviour.
- It defines understanding from the limited perspective of the observer, rather than from a combined perspective of the subject and the observer. It is not based on a psychology of personal meaning.
- It neglects the need to explain varieties of outcomes in understanding.
- It remains inconsistent in its description of the development of understanding -

understanding seems to be lost to the routine, yet old understanding is part of the explanation of new understanding.

Nevertheless, the performance view of understanding does contribute significantly to the need to clarify what we wish to encourage in personal understanding to target understanding relationships in educational contexts. Understanding performances do form a useful component for describing instructional goals. They may also form a useful component of explanatory theories seeking to explain the relative success of those instructional theories.

For example,Mansilla and Gardner (1997) describe how the project identifies four dimensions of understanding. From the perspective of this thesis, this would be described as four dimensions of an instructional theory. They are the knowledge dimension, the methods dimension, the purposes dimension, and the forms dimension. Each dimension can be summarised under two or three criteria. For example, the knowledge dimension can be described according to the criteria of

to what degree the students' performances show that warranted theories and concepts in the domain have transformed their intuitive beliefs,

and the criteria of

to what degree they are able to reason richly organised conceptual webs and move flexibly between details and overviews, examples and generalisations.

The methods dimension has criteria of healthy skepticism, building knowledge in the domain, and validating knowledge in the domain. The purposes dimension involves awareness of the purposes of knowledge, multiple uses of knowledge, and ownership and autonomy. Finally, the forms dimension has the mastery of performance genres, effective use of symbol systems and consideration of audience and context as its criteria.

Hammerness and her colleagues (1997) attempt to begin to assess the achievement of these dimensions in instructional contexts. They categorise people as being novices or apprentices, or masters in the dimensions. In common with the studies by Tan and Novak, and Burns, which were described above, mastery was relatively rarer in the students. The authors admit that they are unable to assess the degree of cause and effect between the teaching for understanding which the students experienced and the outcomes they observed. From our perspective, we would say that they need also to develop an adequate explanatory theory and framework. Nevertheless, they did find a range of outcomes which illustrate the potential for the mutual relationship between

explanation and instruction described in this thesis. The outcomes provide data for instructional theory. The assessment techniques used may also be useful in developing more effective assessments of educational understanding, and so be useful in the practical application of instructional theory. Furthermore, from an instructional perspective, Unger and Wilson (1997) found that students found the descriptions of the four dimensions helpful - particularly when they could see them being clearly practised. At the very least, they seem to be an aid in guiding the students in what is expected in educational target understandings. They make the adaptational requirements of the context clearer and, perhaps, more relevant.

This brings us to the final main issue of this chapter. Using the framework to develop the curriculum.

Developing educational theory.

Various agencies in Scottish education are currently engaged in drawing up blueprints or recommendations for effective learning and teaching (for example, H.M.I. (1996; Higher Still Unit, 1997b; SCCC, 1997b). These publications offer contrasting suggestions for promoting and measuring effective learning and teaching, but all indicate instructional theories which are considered relevant for use in Scottish schools. Here we examine these recommendations in the light of our understanding framework.

For example, the inspectorate (H.M.I., 1996) seek to describe the quality of teaching and learning using indicators such as, the range and appropriateness of teaching approaches, clarity and usefulness of teachers' expositions and explanations, quality of teacher-pupil dialogue, extent of pupil motivation, progress in learning, personal responsibility for learning, and interaction with others. These indicators are derived and developed from inspections of schools in which examples of good practice have been found.

The SCCC document (SCCC, 1997b) takes a different approach. It claims to draw upon what is known about learning and teaching, and to derive from this what is implied for effective learning and teaching. It refrains, however, from giving a general summary. Nevertheless, it does compile a list of principles which seem to be compatible with an epistemology of mind as described earlier. These are divided under the headings, 'How we learn,' 'Effective Teaching,' and 'Teachers as Learners,' and include:

Intelligence is not fixed (Page 4)

Learning involves developing our emotions and feelings along with our ability to think and act. (Page 6).

We learn most effectively when we think things through for ourselves (Page 8)

Knowing what kind of people your learners are, and having some understanding of what they are thinking, is essential for effective teaching (Page 17)

Effective teaching involves talking regularly with learners about their learning, and listening to them. (Page 18)

Teachers' own preferred ways of learning tend to affect the ways in which they teach. (Page 21)

Neither document states any principles which would be contradicted by our framework, however, they are by no means fully integrated instructional theories. For example, one of the principles of learning in the SCCC document is that *learning is messy* (Page 8). By that, it implies that learning does not usually proceed along a linear path to predetermined outcomes, and that plans for learning which are too detailed can actually prevent or distort it. However, the document makes no attempt to reconcile this with current forms of syllabus or assessment, which as discussed earlier, and in science at least, often demand particular outcomes and responses. Remove the syllabus and assessments from consideration, and these principles seem to be interpretable as much as an argument for the sort of informal education of the Plowden era (see Bennett, 1989 for a description of the type of classroom activity envisaged which seems to match the principles outlined in this document). These questions of specific assessments and syllabuses are not even raised as issues for further consideration.

This question of the syllabus is an important one. One issue which is not considered is the possible conflict between teaching a discipline and teaching for everyday life. In Chapter 7, the differences between science as a target understanding and everyday target understanding were discussed. The former was found to depend on developing a particular way of thinking with its own concepts. Learning is not only messy, but involves different demands upon the learner according to the purpose. The demands of learning for everyday life are not the same as for learning a science discipline. The document does not touch on this issue, but the conflict exists in practice. For example, when teaching electricity to second year pupils (approximately age 13), teachers are

encouraged to include practical and everyday activities, such as wiring a plug and changing a fuse. However, in the teaching materials provided, little attempt is made to indicate the science behind the plug - the concept of alternating current, flow of electrons, resistance and heat energy, insulation, and so on. The activities assume little more than a low level technology.

In fact, in the author's experience, there has been a retreat from teaching some of the major integrative concepts of science. Atoms and molecules become just particles for first and second year pupils, and remain so for those pupils who do not move on to third year chemistry or physics, including those pupils who take biology but not chemistry. Also, concept building can be difficult. Pupils in biology are expected to grasp the concepts of diffusion and osmosis, with only a very limited conception of the particulate nature of matter. More careful consideration needs to be given to this whole question. Are we teaching for a form of scientific conceptual development, or are we teaching bits and pieces of useful technological applications? Can we make better use of the technological applications to teach the science? What concepts do we need to teach as a basis for building the others?

This problem is even more pertinent with the current vision of progression in the curriculum. For example, pupils who get an inadequate grade to pass to Higher Grade Biology from Standard Grade, can take an intermediate course. However, the content of this course is virtually identical to that of the Standard Grade course - a recipe for boredom for both the pupils and the teachers. This problem could be resolved by moving away from the focus on content to a focus on concepts and how they build on each other. Content can only be taught in limited ways. Concepts can be taught using various illustrative methods. In a document entitled, "Teaching for Effective learning," we might expect these issues to be given more careful consideration.

Similar conflicts arise in the inspectorate's document. This suggests that overall attainment can be measured in terms of four indicators: attainment in coursework, attainment in national targets/examinations, quality of pupil learning, and meeting pupils' needs. However, there seems to be no recognition that these may conflict. In other words, can we be sure that courses and national assessments truly match with pupils' needs and do not interfere with any independent attempts by teachers to meet these needs. Alternatively, are pupils' needs best defined as coping with a course and its assessment. If so, on what grounds? Include the syllabus and national assessments in the thinking and we are faced with problems of whether these are consistent with

learning and understanding. Again, there is no indication that this has been considered

- an omission which, perhaps, in part derives from overlooking the research literature on pupils' interpretations of learning situations.

The issue can be put in terms of the discussion in Chapter 4 of the idea of an epistemology of problem solving being between those of intelligence and mind. There are elements, even strong elements, of an epistemology of mind in the language of these documents as they talk of meeting pupils' needs. However, the accompanying emphasis on external exams, at least in their present form, puts pressure on teachers and pupils to emphasise the utility of what is being learnt. Success for education is found in external exam results, as the measures of pupil performance and understanding. There seems less emphasis on personal meaning than the echoes of an epistemology of mind in the documents would suggest. Education is not preparation for an inevitable lot in life, as the epistemology of intelligence would suggest, but its value remains primarily one of helping people to find useful roles in society. However, education is a costly enterprise, and being useful will always be a constraint on its freedom. Nevertheless, it was suggested in chapter 4, that an epistemology of mind does not replace those below it in the model in Figure 7. It accommodates them. The question is one of finding how to apply an epistemology of mind consistently, so that personal meaning and utility of educational outcomes are not incompatible.

The problem seems to be twofold. Firstly, there is no explanatory theory at the educational level upon which these documents draw in order to base any claim they may make to being effective instructional theories. Thus, although they do draw upon selected research evidence, there is no vision as to how the principles come together as a coherent explanatory theory. In consequence, the reading of the research literature is simplistic and one-sided Secondly, and in consequence of the lack of an explanatory framework, the instructional theory which emerges is incomplete and inconsistent. In addition, the lack of an explanatory theory means that we are not given a rationale for including the chosen principles, other than, in SCCC (1997b), some select quotes from research. We are left to wonder if there are alternative lists of principles for effective learning and teaching, and if so, on what basis have they been omitted?

However, the above documents are not without value. They serve to state a current position in instructional theories, and what we need to do to improve upon them - namely, develop an educational explanatory theory in which they can be grounded and seek to make them more coherent. A third document (Higher Still Unit, 1997b) takes a third, but very brief, approach to describing effective learning and teaching (Figure 18). In this case, a learning cycle is presented as a way to promote learning. Again, this seems to be offered on the unspoken assumption that the syllabus and

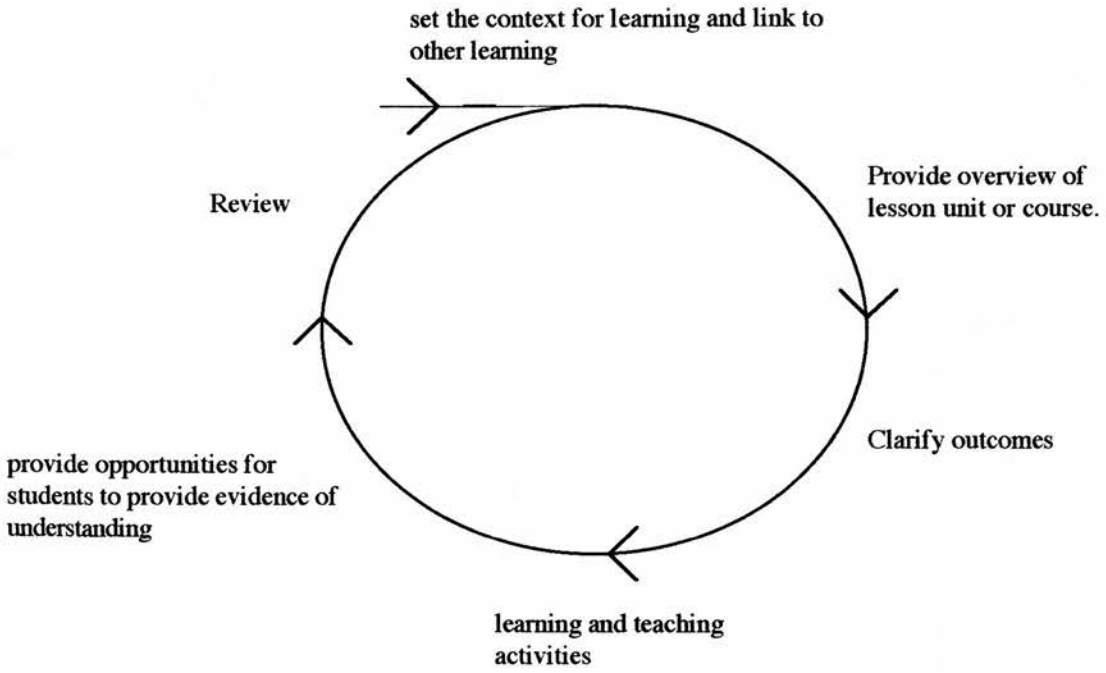

FIGURE 18 : BASIC PRINCIPLES OF EFFECTIVE LEARNING AND TEACHING AS PART OF A LEARNING CYCLE. (Higher Still Unit, 1997B, Page 2)

assessments are a good measure of pupil understanding, but in this case the issue can be directly addressed by both explanatory theory and instructional theory.

Whatever course or syllabus is set up, it seems uncontroversial to see the cycle as being a useful tool to describe both what need to be included in instruction and explanation. We can ask:

What are the best conditions for learning a particular 'educational discipline'[3] (explanatory)?

How do we provide the best conditions for learning an educational discipline (instructional)?

What range of forms of understanding do pupils demonstrate in relation to a particular educational discipline as taught and why do they show this range (explanatory)?

What forms of understanding is it desirable to promote in relation to an educational discipline and why? How do we promote these forms of understanding (Instructional)?

How do forms of understanding in educational disciplines relate to forms of understanding in other contexts within our society (explanatory)?

How do we want forms of understanding in educational disciplines to relate to forms of understanding in other disciplines (Instructional)?

How do forms of assessments affect the range of forms of understanding that pupils show in relation to an educational discipline (explanatory)?

Do we wish assessments to aid in limiting the range of forms of understanding that pupils show in relation to an educational discipline? If so in which ways and what assessments do we use (instructional)?

These questions for explanatory and instructional theories relate to, or have implications for all parts of the learning cycle. However, they are perhaps best illustrated in relation to the part of the cycle where opportunities are provided for

3 'Educational discipline' can be applied more loosely than previously to include the more academically based courses such as Higher Biology, the more watered down forms of discipline based courses such as general science courses for the less able, non- specialist and younger pupils, and courses which have a social rather than academic function such as social education courses.

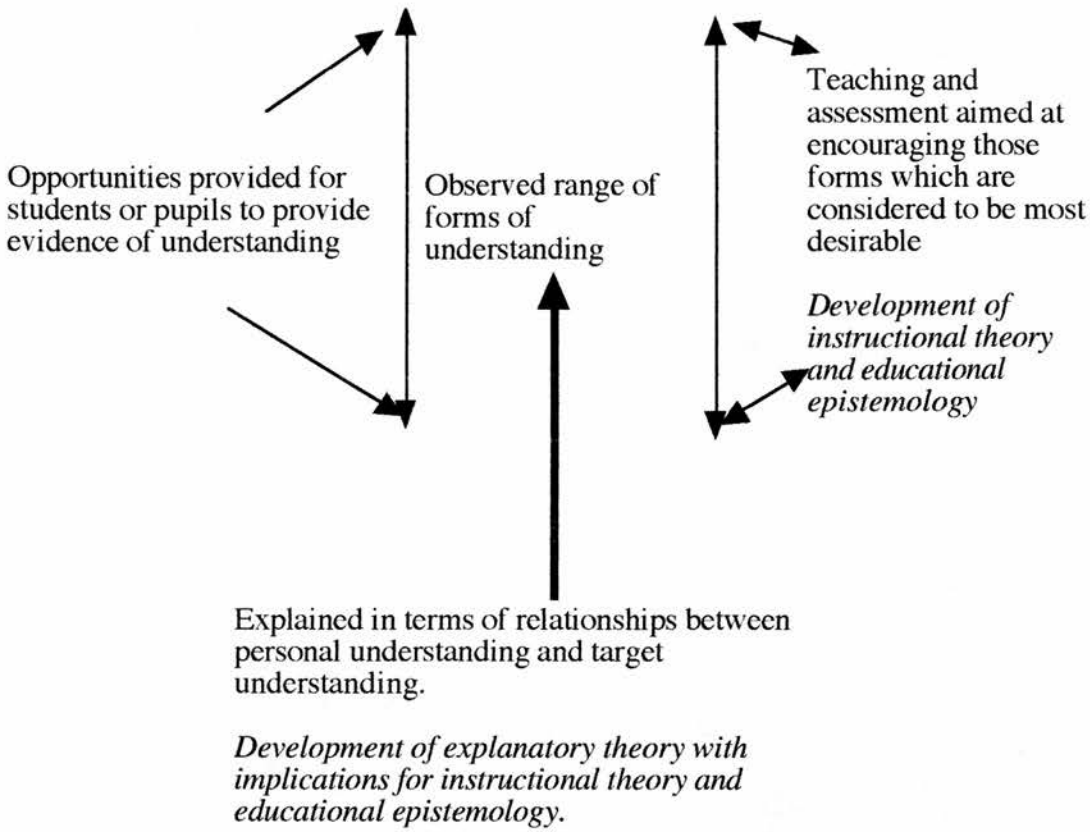

FIGURE 19: AN ILLUSTRATION OF HOW THE FRAMEWORK CAN BE USED TO LINK EXPLANATION AND INSTRUCTION

students to provide evidence of the forms of understanding which the instruction is seeking to foster (Figure 19).

In providing opportunities for students to demonstrate their understanding, we would expect a range of forms of understanding to emerge. Then explanatory theory would seek to explain this range of forms in terms of the relationships between personal understanding and target understanding, and the concepts which are incorporated within this way of looking at understanding. The range of forms of understanding emerging from an application of a particular instructional theory would therefore be, as argued before, one source of data for explanatory theory. Other sources of data would derive from research based upon the background concepts as discussed in the previous section. Explanatory theory would have implications for instructional theories and educational epistemologies, but they must also deal with questions of in what and how it is desirable to educate learners. When aware of the range of understandings which leaners develop in particular educational contexts, choices can be made as to what forms will be encouraged. A major task for instructional theory would therefore be to develop not only the processes of teaching and learning to encourage these forms of understanding, but also to develop means of assessment which both allow the desired forms to be demonstrated and genuinely encourage them. As described above, the work of Project Zero has made some progress in this form of application of instructional theory.

Final word

This is an exciting time for educational theory and practice. Understanding is a complex subject for explanation, but we are beginning to see some possibilities as to how we may achieve it. To handle this complexity it has been argued that we should use a framework in which a distinction between personal understanding and target understanding is made explicit. In this way we can begin to see how to bring together the various concepts and issues which relate to understanding in educational contexts.

The complexity of explanation required inevitably leads us across disciplinary boundaries. This is one reason for trying to place education within the hierarchy of explanatory disciplines. It helps us to keep a clear head when we move across normal boundaries and to co-operate in the sharing of expertise. Lerner (1991) notes the conceptual and methodological complexity which inevitably results as we cross disciplines in our attempts to study any form of changing organism-context relations. This complexity arises as both organism and context change in development. Nevertheless, he encourages us to remember that, although it is impossible to be an

expert in all facets of a multi-disciplinary setting, we can attempt to overcome scholarly limits in a collaborative, multidisciplinary milieu.

The means through which we do this do not, however, involve a rejection of a focus in one's disciplinary background and training. Rather, one should work to reorient the approach taken in one's discipline to formulating the questions deemed most important to address. Simply, one should ask change-orientated questions, relational questions, questions that bridge levels of analysis and that require multidisciplinary collaboration for their answer. (page 29)

An attempt has been made to be part of this process. However, let us not finish by being too 'weighed down' by complexity. Complexity of explanation does not necessarily imply complexity of application in instructional theory. Indeed, it may point to a simplification of a system which teachers feel is becoming ever more 'bogged down' in complex systems of assessment and re-assessments (see for example, E.I.S., 1997; The Herald, 1997). The potential for yet further increase in this complexity of assessment procedures in science in a recent curriculum document (SCCC, 1996b) has already been noted, arising from the further breakdown of science into a wider range of strands by the authors. Something which, on past form, seems likely to lead to attempts to devise assessments for each strand.

An alternative strategy emerges here. Firstly. identify the forms of understanding in various contexts and devise teaching methods to encourage the most desirable forms. Secondly, if necessary, devise teaching and learning schemes for leading learners from less developed to more developed forms of understanding. In particular, if we can keep the assessment of understanding relatively simple and clear, and the work of Project Zero suggests this is possible, this is also an exciting and challenging time for educational practice. Teachers may get the tools they need in the form of both a coherent curriculum, truly rational and well structured subject syllabuses, and a pedagogy comprising a language and methodology which is geared to understanding of the highest possible form.

We may be able to achieve this simplification by developing an instructional theory which is internally consistent and also consistent with the prevailing educational epistemology - assuming this remains the epistemology of mind. Clearly much research and development work of both explanatory and instructional theory requires to be done, but the possible rewards for researchers, curriculum developers, teachers and pupils make the effort seem to be worthwhile. The framework in this thesis offers one way in which the roles of all of these can be better brought together in cooperation. It is multidisciplinary not only for explanatory researchers, but also between researchers and educational practitioners.

In summary, the framework arising from thinking about understanding as a range of relationships between personal understanding and target understanding offers:

- integration of a range of concepts into an explanatory theory of understanding for education,
- a means of connecting explanatory theory in education to connect to other contexts of explanation,
- the generation of a range of research hypotheses and the bringing of them together under a common goal
- a strengthening in the connection between educational explanation and educational practice into more mutually beneficial relationship. A relationship in which collecting the data for explanatory and instructional purposes becomes a shared task between the teacher and the researcher.

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